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Page	97,	line	14	from	top,	for	*Derming's*, read *Denning's*.
"	88,	"	23	"	"	"	*fifty five*, read *forty five*.
"	100,	"	20	"	"	"	*longer*, read *larger*.
"	103,	"	18	"	"	"	*Casson*, read *Capon*.
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NUMBER II.

MISCELLANIES.—DOMESTIC AND FOREIGN.

* Repeated through inadvertence; it was in the preceding number.

ERRATA, AND ALTERATIONS FROM MS.—VOL. XIX.

Art. V. page 46, for C′ whenever it occurs, read *c′*.

" 49, 5th line from top, for 1, read —1.

Page 49, 3d line from bottom, instead of "If the impulses act continually," substitute If the impulses are indefinitely small and act continually.

Art. IX, page 61, first line, after *have* read *not*.

Page 135, line 2d from top, for *their* read *these*.

" " " 14th from bottom, for *of* read *to*.

" 136, " 15th from bottom, for *professedly* read *professionally*.

" 137, " 10th from bottom, for *design* read *degree*.

On Stone [illegible] Engraved

COAL MINE AT MAUCH CHUNK

Lithe by C G Childs Philadelphia

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*Notes on a journey from New Haven, Conn., to Mauch Chunk and other Anthracite regions of Pennsylvania.**—*Editor.*

STEAM BOAT CONVEYANCE.

May 10, 1830.—In the morning we travelled by stage, from New Haven to Norwalk, thirty miles, and in the afternoon, by the steam boat John Marshall, to New York. This commodious vessel has two boilers, on her wings, entirely over her sides, so that neither steam nor water can enter the cabins. The public are much indebted to the Messrs. Stevens for the introduction of this excellent arrangement; for an explosion cannot affect the passengers below, and both the chance and the mischiefs of explosion are diminished in proportion as the boilers are smaller.

May 11.—The steam boat Bellona conveyed us from New York to Elizabethtown point, fifteen miles. There are two boilers in this boat, also, one on each side, but both are under the deck; this gives more room above than if the boilers were on deck, but explosion will of course fill the cabins with steam and boiling water, and the chance of sinking, on account of injury to the bottom of the boat, is much increased. This subject is worthy of the highest efforts of the greatest minds, and a munificent reward should be offered by the government of the United States for the discovery of an absolute preventive of explosion, or an absolute security against its effects; and for the accomplishment of both objects, the reward should be doubled.

The advantages of steam navigation are so great and manifold, and to this country so indispensable, that they cannot be abandoned; steam navigation has become an integral part of the domestic policy of the country, and will be pursued, even with all the hazard to life,

* With the company and assistance of Mr. George Jones author of the Naval Sketches, &c.

that now attends it. It can however be scarcely doubted, that science and mechanical skill, which have created and applied this wonderful power, will yet effectually succeed in directing and controlling it, and in preventing or in parrying the effects of these terrific explosions which have so often proved extensively fatal. Towing* seems to present, on all quiet waters, the best preventive of disaster to passengers, while those concerned with the management of the steam vessel, will, of course, as they alone are concerned, exercise increased vigilance for their own safety. This arrangement by towing, being however merely a transfer and not an extinction of the evil, every motive for effort in the exercise of invention and skill still remains. If the plan of Mr. Perkins, of creating the steam no faster than it is needed, and using it as fast as created, could be rendered easily practicable on a great scale, it would answer the purpose, and every improvement by which the power actually created can be applied, with a diminution of the great loss† which is now sustained, would be an approximation towards the desired result, because it would admit of a proportionate diminution in the size of boilers, and of course in the danger and mischiefs of explosion.

The plan of having two boilers and of placing them over the sides of the vessel is so great an improvement, that (unless there is some very decisive objection of a practical kind, not yet made public,‡) all steam boats ought hereafter to be constructed in that manner. The accommodation and comfort of the boat are very much increased by removing the fires and the boilers, and if a separate fire for cooking is needed, it is easily arranged, and would be attended by no peculiar danger or inconvenience. The passengers may be screened from the effects of explosion, should it happen, by a strong bulwark of timber erected between the deck and the boilers, and the security would be then rendered almost complete; perhaps it would be quite

* Particularly as recently suggested in the public prints, by Mr. John L. Sullivan, (well known as an able civil engineer,) and as now happily revived in the Lady Clinton on the waters of the Hudson.

† It has been, within a few years, stated in France, that only one twelfth part of the power actually generated by steam is applied, the rest being wasted; more recent improvements may have diminished this loss, or it may have been exaggerated, but if any near approximation to this statement is true, it proves, that there is a fine field open for practical improvement in diminishing the size of boilers, and in applying the power of steam.

‡ Such, for instance, as that the boilers over the sides may be less eligible in rough seas, where the rolling of the vessel might be, in this manner, increased, and the management of the fire be rendered more difficult. I have never however, heard this stated as a difficulty.

so, if, as suggested by a correspondent, the boiler were covered also at a proper distance above, and at both ends, by the bulwark or case of timber, leaving only the outside (towards the water,) unprotected, and that side, or a part of it, while it is made sufficiently strong to resist any proper pressure, should be decidedly weaker than the other sides, so that if explosion happens, it may spend its force outwards. The fuel immediately wanted, might be kept on the top of this bulwark, and the fire might be fed by a communicating gallery, from the outside. The engineers and firemen must always, from the nature of the case, be more exposed than any other persons; but they will be more careful the more the danger is rendered exclusively personal, and the frequency of explosions will on that account be diminished. This subject cannot rest where it is; additional improvements are demanded for the public safety, and they will, no doubt, be made.*

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* *Steam Generator of J. O. Blair.*—It would seem from an account of a steam generator invented by Mr. J. O. Blair, late of New Orleans, signed by a committee of the Philosophical Society of Cincinnati, that the following advantages are supposed to be attained by this contrivance.

1. Economy of fuel and simplicity of construction.
2. In case of explosion, it will, in a steam boat, be outwards and overboard.
3. The generator will be always supplied with water.
4. The head of the boiler is nearly dispensed with, as the flue is composed of two cones, joined near the center, and the base of the cone nearly fills the mouth of the cylinder of the boiler.
5. The weight of the water, and the danger of the adhesion of earthy matter to the boiler, are much diminished.
6. A hydrostat gives constant information of the quantity of water in the generator and an alarm valve instantly indicates a deficiency of water.
7. The generator is supplied with water by pumps wrought by a cylinder distinct from that which propels the boat.
8. Generators twenty inches in diameter are stated to be sufficient for any engine and that, if made of good iron one fourth of an inch thick, they will sustain twelve hundred pounds pressure, on the square inch, while only one hundred and twenty will be required.
9. The rocking of the boat does not uncover the metal so as to expose it to become red hot, as more than five sixths of the surface of the generator may be safely exposed to the action of the fire.

These advantages are too important to be overlooked, provided it should appear on full trial, that they have not been overrated; and the statement, signed by Calvin Fletcher, J. C. Bush and John S. Talbert has every appearance of being a fair and correct account of the new generator. It is contained in a Cincinnati paper of July 12th, forwarded by Hugh Peters Esq., to the Editor.

Remark.—An intelligent correspondent sates, as the result of his own inquiries, that not less than one thousand and five hundred persons have been destroyed in this country by explosions of steam boilers.

RIDE TO EASTON.

From Elizabethtown point we passed through Springfield* and Morristown, a part of the classic ground of the revolution. At the latter place, the house which was the head quarters of Gen. Washington while the army lay three miles south, on the declivity of the mountains, is still shewn. Here the troops remained stedfastly encamped, during the tremendous winter of 1779–80, when their tents were often buried in the snow, or overturned by the tempests of that dreadful season. To this strong hold, Washington retired after the successful battle of Princeton, and thus secured the advantage he had won.

Morristown is a handsome inland town, situated in the midst of a beautiful country, soon to be enlivened by the commerce, which will flow through the Morris canal, now drawing near to its completion; this will connect the Delaware, at Easton, with Newark bay, and of course with New York, to which city the important produce of the Lehigh coal mines will then be transported with the same ease as to Philadelphia. Morristown is twenty eight miles from New York. From this place to Schooley's mountain the face of the country is both grand and beautiful. Meadows of intense verdure, orchards, and mountains with rich forests, are constantly in view. At Morristown, we leave the trap and sandstone country, which cover the middle region of New Jersey, and fragments of primitive rocks begin to be abundant, especially on Schooley's mountain; none however were observed in place, but they might have been unnoticed in the obscurity of a rainy day, and of a curtained coach. We had no time to search for the zircon crystals, or to taste the mineral waters, which have here gained considerable celebrity. From Schooley's mountain to the Delaware, the beauty of the country constantly increased. We rode between two barriers of mountains, which attended us with great regularity, but at such a distance as to admit of wide fields between; these fields were covered with luxuriant grass and wheat, and being kept in fine order, were a constant subject of admiration. The descent of a long and steep hill with a high precipice on the right, at only a few feet from the coach, one of whose wheels was locked for safety, brought us, at dark, to Easton, and to the enjoyment of Pennsylvania hospitality and plenty.

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* In whose vicinity there was a sharp battle during the revolution.

May 12.—A view from the heights in and about Easton, includes the Delaware, which is here a roaring rapid river, with bold and precipitous banks; the picturesque Lehigh and its attendant canal; fine verdant slopes, and an ancient respectable town, built principally of stone, with a population of 2500 to 3000. Easton was, in former times, the seat of many Indian treaties, and was one of the usual channels of communication between the eastern colonies and northern Pennsylvania.* It has in its vicinity a fine serpentine formation; and the beautiful cabinet of Dr. Swift, presents that mineral in distinct crystals: it is of the variety called noble serpentine, which appears thus clearly entitled to rank as a distinct mineral species. In Dr. Swift's well selected and well arranged collection there are splendid crystals of zircon found in this vicinity, and the most beautiful crystallized mica in long prisms of six sides. We were indebted to the kindness and intelligence of several of the gentlemen of Easton for much valuable local information.

RIDE TO MAUCH CHUNK.

We passed between Nazareth and Bethlehem,† the two most celebrated establishments of the Moravians in this quarter, and regretted that we could not then see them; for we were in a private carriage, which, as the roads were heavy, was merely able, without stopping or changing horses, to convey us, in one day, to the celebrated coal mines on the Lehigh, thirty six miles from Easton. On our way we passed through a most beautiful country, a continuation of the rich valley which we had, the day before, so much admired in New Jersey. The farms were adorned with the finest grass and wheat; the latter in very extensive fields, cultivated by a German population; females were

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* Most of the emigrants from the east to the valley of Wyoming, travelled through the country on the higher branches of the Delaware, and left Easton to the south.

† On our return home, by the way of Philadelphia, we passed through these beautiful towns, but as we merely stopped for refreshment, a hasty walk through the streets of Bethlehem afforded only a transient opportunity of admiring this charming spot. The stability, order and neatness of the town, are sufficiently remarkable, and bear testimony to the industry and order of the excellent people that founded it: its female seminary is a conspicuous object, and the scenery as we descend from it to the Lehigh, which (here a full flowing stream,) winds among lovely hills and meadows, is not surpassed by the finest park and forests scenes of England, to which it bears a great resemblance.

often observed laboring on the farms, and even in some instances holding the plough and governing teams of horses. When we observed them working vigorously in the gardens and at the wood piles, they discovered no embarrassment at seeing strangers, and doubtless from habit, they felt none. The Pennsylvania Germans are very industrious and thrifty farmers, but with some honorable exceptions, they, in general, undervalue education and knowledge,* and are quite satisfied to go on as their fathers went before them, and they almost systematically shut their eyes against the lights of the age; but they are truly a stable population.

Many mountain scenes engaged our attention, particularly as we approached the gap in the Blue Ridge, through which the Lehigh passes. This mountain range stretches for many miles, in a straight line to the right and left, presenting a regular barrier, fringed with forest trees, and wooded on the entire slope, which was as steep as it could be and sustain the wood upon its sides. As we approached the gap, the view became very beautiful, and as we entered it by the side of the Lehigh and of the fine canal upon its left bank, the mountain ridge, here cleft from top to bottom, and rising apparently a thousand feet, presented, on either hand, a promontory of rocks and forests, rising very abruptly, and forming a combination both grand and beautiful. The passes of rivers through mountains are almost invariably picturesque, and it is always interesting to observe, how faithfully the rivers explore the clefts in mountain barriers, and impelled by the power of gravity, wind their way through rocky defiles and pursue their untiring course to the ocean. It is common to speak of such passes as being formed by the rivers, which are often supposed to have burst the barriers, and thus to have shaped their own channel. This may have happened in some peculiar cases, and there are doubtless many instances where the lakes, of which many must have been left at the retiring both of the primeval and of the diluvial ocean, have worn or burst away their barriers, especially when composed, as they must often have been, of loose materials. But with respect to most rocky passes of rivers through mountains, there appears no reason whatever, to believe that the waters have torn asunder the solid strata; a more resistless energy must have been requi-

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* In the taverns they offered us *cider royal;* it derives its title *par excellence*, from the whiskey or cider brandy, which, in the proportion of three or four gallons, is added to each barrel of cider.

site for such an effect, and we must therefore conclude, that the rivers have, in most instances, merely flowed on through the lowest and least obstructed passages; their channels they have doubtless deepened, and modified, often to an astonishing degree, but they have rarely formed them through solid rocks. Soon after passing Lehighton, a little village three miles from Mauch Chunk, we entered another pass, which the Lehigh makes through the mountains. It is not like the former a section of the barrier; it is rather a long circuitous gorge between two barriers, which, although they pursue a winding course, still preserve their parallelism; and their feet, near Mauch Chunk, approach so near to each other that there is only room for the Lehigh and the canal on one side, and for a road cut into the mountain on the other; it is so narrow that the river is almost within reach on the right, and the mountain rocks are quite so on the left.

MAUCH CHUNK.

THE RIVER AND CANAL.

At evening, we found a fine hotel in this wild gorge, where there is scarcely room for the house, which, in the rear, is overhung by the mountain, while the roaring Lehigh rushes by in front. This roaring is increased by a dam which, with many others, was erected some years ago, for the purpose of improving the navigation by producing still water above; the arks passed through sluices which could be opened and closed at pleasure, and were not expected to return, being broken up and sold at their places of destination. Since the construction of the canal, the dams have a more limited use, although they still answer a valuable purpose in some parts of the river, by producing still water, and there is in such cases a towpath along the bank, so that the river becomes a substitute for a canal; the latter is however here chiefly relied upon, and it is obvious that in a river so rapid and turbulent as this, requiring for the purpose of making still water, numerous dams at very short intervals, such an arrangement must be inconvenient, and therefore, a canal has been constructed at great expense along its banks, and that not only because it admits of navigation both up and down stream, but also for safety and certainty; for property sunk in it, (a rare occurrence compared with the frequent accidents in the river,) is easily recovered, but in the river it is usually lost. Some dams are however still necessary in the river, to raise the water for feeding

the canal, and in some parts of the river there is no need of a canal, as the river, made still by the dam, answers the purpose very well. The comparative advantages of canal and still water river navigation must depend entirely upon the circumstances of particular rivers; had the Lehigh been a quiet stream, with a gentle descent, and few obstructions, so that a dam would have made still water for many miles above it, and therefore a few dams, with long intervals, would have answered the purpose; then, by short canals and locks, enabling boats to pass securely either way, up stream or down, without encountering the danger of sluices, a secure and desirable navigation might have been obtained, as it now exists for ten miles in that river. The experiments that are now making in various parts of the United States, will enable the public to judge which mode is preferable, in particular cases, and when to combine both modes, by preferring the one or the other, in different rivers or in different parts of the same river, as circumstances may require.

The canal along the Lehigh is a noble work; the banks are firm, and lined chiefly with stone; the locks are twenty two feet wide, and one hundred long, and are constructed of hewn stone, laid in hydraulic cement, and faced with plank. This canal, which is sixty feet wide at top, and forty five at bottom, with five feet water, follows the Lehigh to its junction with the Delaware at Easton; the distance is forty six miles, thirty six of canals, and ten of slack water pools; the ascent from Easton to Mauch Chunk is three hundred and sixty four feet; there are fifty four locks, and nine dams.

At present, the coal is carried to Philadelphia in temporary flat boats, called arks, which at Easton are launched into the Delaware; but as soon as the canal which is now constructing along the west bank of that river, is finished, which will be the present season, there will be a complete canal navigation from Mauch Chunk, to Bristol, eighteen miles above Philadelphia, and the whole distance from the mine to Easton will be fifty five miles, including the rail way of nine miles on the mountain: the length of the Delaware canal is sixty miles, so that the whole distance from Mauch Chunk to Philadelphia, is one hundred and twenty four miles. The improvements above Mauch Chunk are for a descending navigation only.

SCENERY.

May 13.—Fog and rain obscured the wild scenery of the valley, but did not retard our visit to the mine. We ascended the steep

which forms the termination of the Mauch Chunk mountain, nearest to the village; it is called Pisgah, not without some propriety, for the view which it affords, although bounded on every side by near mountain ranges, is highly interesting, and forms a combination almost unique.

The rail road on the mountain leading to the mine, and the chute as it is called, by which, at a great angle, the coal wagons descend to the Lehigh, presenting a scene of busy industry, first attract your attention, and then the zigzag defile in the mountains, with the rapid river and the serpentine canal, which, at the remoter extremity, are cut off from view by the winding course of the double barrier; then, another gorge branching off from the first, stretching away to the right, enlivened by a rapid rivulet, and containing on one narrow street, most of the dwelling houses of the village; then, another turn to the left by which the Lehigh passes; at your feet are scenes of active labor, in constructing, launching and filling the coal arks; in casting iron for the mines and rail ways, and in other modes of industry relating, to the local objects of the place; on all sides, the grand ridges and precipices of wooded mountains, a thousand feet high, grouped in apparent confusion; and, as we saw them, hung around with the drapery of clouds and mist, sufficiently broken to admit the sunbeams, which tinged the ragged masses of vapor, and the mountain ridges, with iris hues; all these objects presented a combination of grandeur, beauty and variety rarely surpassed.

THE RAIL-ROAD.—THE CHUTE.

May 14.—As we made two visits to the mine on two successive days, the observations of both days may be blended.

The rail road commences at the Lehigh river, and ascends at the rate of one foot for three and an half of the slant; the whole ascent to the top of the promontory is two hundred and fifteen feet and the slant is seven hundred feet. This part is for the descent of the coal wagons from the main rail way to the river. There is at the top of the hill, a building, containing the machinery by which the coal wagons are governed in their descent. The most important part of it is a large cylinder or drum, revolving horizontally, and serving to wind the rope or small cable which governs the wagons; the latter are rolled in by hand from the main rail way, and are placed in a correct line of direction with the inclined plane, called the chute; this is effected by pushing the wagons upon a horizontal circular platform,

lying even with the floor, and which by revolving horizontally on a pendicular axis, instantly brings the wagon into the proper position, from which they are launched upon the inclined plane, and then they descend by gravity; the rapidity of their progress is checked by the weight of the ascending empty wagon, which being fastened to the other end of the rope, and moving on a parallel rail way, but on the same plane, necessarily runs up hill as rapidly as the loaded wagon runs down, and when it arrives at the top, it is transferred to the upper rail way by turning the circular platform in the manner that has been described. Accidents have been rare in this descent, but the wagons have sometimes deviated or broken loose, and one man has been killed. They are now guarded against by a very simple, yet ingenious contrivance. The rail way is double until the most rapid part of the descent is passed, when both ways curve and unite in one. Should a wagon then break loose, its momentum will be so great as to prevent its following the curve and as soon as it reaches this spot it is thrown out, overturned and lodged on a clay bank formed for this purpose below. Farther down, a bulwark is constructed, overarching the rail way, in order to intercept the loose coal as it flies from the wagon. A key at the proper place makes each wagon take its own road on leaving the common one. The delivery of the coal into the arks is effected by a contrivance, at once very simple, ingenious and effectual. The ark, which is a large flat bottomed boat or scow, lies in the river, at the foot of the inclined plane, and the wagon, on arriving at this point, makes a sudden pitch into a downward curve in the rail way, and a projecting bar that secures the lower end of the wagon, which, for this purpose, is hung on a horizontal axis, knocks it open, and the coal slides down a steep wooden funnel, into the ark; the impulse given to the latter by the falling coal, causes the flat boat to recede rapidly from the shore, and thus the coal is, without manual labor, spread evenly over the bottom of the ark. The arks contain each about twelve or thirteen tons; there is, at present, a loss upon them at the rate of a dollar a ton, and they will be discarded this summer, as soon as the canal along the Delaware is finished, and regular canal boats will be substituted.

The arks are composed chiefly of pine boards, put together in cross courses, with straight and smooth edges, and joining surfaces, and secured by nails. They are made very rapidly, usually the same day that they are filled with coal. As they depend chiefly for the tightness of these vessels upon the accuracy of the joints, there is an ingenious contrivance used here, by which a long joiner's

plain is, by a machine, drawn the length of board, at a single movement, and unavoidably produces a correct surface, which of course fits another made in the same way. When the boards are nailed in their places, they are pressed close together by machinery, and then the nails are driven. There is also a machine for raising the boats from the floor, one edge resting upon it, so that the workmen can go under them. Although they will be soon disused in this place, they may be useful elsewhere, and the ingenious contrivances by which they are so rapidly constructed may be applicable in other cases.

THE MAIN RAIL WAY.

It has only one track, and is nine miles long to the mine, and eight miles to the highest point; its branches and sidling cuts are four and a half miles more; it descends at the rate of 100 feet in a mile. There are two places for turning out, made, as usual, by a curved rail road lying against the main one, and forming an irregular segment of a circle resting upon its chord. The rail way is of timber, supported by cross pieces of the same, and the rail is shod on the upper and inner edge with flat bar iron. It was laid down with surprising rapidity, for it was actually in use within a little more than three months from the time when the timber was growing in the forest.* Its cost was something over $3000 a mile.

A traveller makes the excursion to the mine with very little fatigue, in a pleasure car which is drawn on the rail way by horses, and the journey up occupies only one hour. You can descend into the mine in the car, but it is usual to leave it at the summit level and descend on foot.

This great excavation is at the termination, and nearly on the summit of the Mauch Chunk mountain. Nothing can be more obvious and intelligible than this mine. They have removed the soil and upper surface of loose materials, and come directly down upon the coal or upon the rocks which cover it.

GEOLOGICAL STRUCTURE.

The geological structure of this coal formation is extremely simple. As far as we saw, the upper rock is a sandstone, or a fragmentary aggregate, of which the parts are more or less coarse or fine in different situations. In this region there is much puddingstone and conglomerate, and much that would probably be called graywacke,

* Begun in January, 1827, and finished in May following; more than 100,000 tons of coal have been transported upon it, and its use, during the time of the year when the canal was open, has never been interrupted, a single week, since it was constructed.

by most geologists. In the mechanical aggregates, which abound so much in this region, the parts are of every size, from that of large pebbles to that of sand. The pebbles are chiefly quartz, and even in the firmest rocks they are usually rounded and exhibit every appearance of having been worn by attrition. The cement appears to be a siliceous substance, and the masses are frequently possessed of great firmness.* Beneath this rock, there is usually some variety of argillaceous slate, which commonly, although not universally, forms the roof of the coal: sometimes the sandstone is directly in contact with the coal, the slate being omitted; the slate also forms the floor.

THE MINE.

The mine at Mauch Chunk occupies an area of more than eight acres, and the excavation is in platforms or escarpments, of which there are in most places two or three. The coal is fairly laid open to view and lies in stupendous masses, which are worked, under the open air, exactly as in a stone quarry. The excavation being in an angular area and entered at different points by roads cut through the coal, in some places quite down to the lowest level, it has much the appearance of a vast fort, of which the central area is the parade ground and the upper escarpment is the platform for the cannon. The greatest ascertained thickness of the coal is stated at about fifty four feet; in one place it is supposed to be one hundred feet thick; but that which is fully in view is generally from twelve to twenty or or twenty five, and even sometimes thirty five feet. Several banks of these dimensions are exposed, interrupted only by thin seams of slate running parallel with the strata. The latter are inclined generally at angles from five to fifteen degrees, and they follow, with very great regularity, the external form of the mountain. In some places, they are saddle- or mantle-shaped; in some positions they and the attendant strata are wonderfully contorted, twisted and broken, and in one place, both are in a vertical position, while at a little distance they return to the general arrangement. It is impossible to avoid the impression that some great force has disturbed the original arrangement and either elevated or depressed some of the strata.

The various entrances to the mine are numbered. At No. 3 there is a perpendicular section through all the strata down to the floor of

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* Exceedingly resembling the millstone grit, and sandstones of the English coal measures; on comparing the specimens from Penn. with those in a collection recently received from Mr. Bakewell, (author of the geology) I can mark no important difference.

the coal, and the graywacke, the slate and the coal are all raised on edge; the strata are in some places vertical, or curved, or waving, and they are broken in two at the upper part and bent in opposite directions.

Has subterranean fire produced these extraordinary dislocations? It would seem to favor this view, that the graywacke has, in some places contiguous to the coal, the appearance of having been baked; it appears indurated; it is harsh and dry, and it is inflated with vesicles, as if gas, produced and rarefied by heat, was struggling to escape. The appearance is, in these respects, very similar to that which was described in Vol. XVII. p. 119 of this Journal, as exhibited in connexion with the trap rocks near Hartford, Connecticut, although it is less striking.

It is obvious that whatever causes have produced the peculiar forms of these mountains and of their attendant strata, have given the same form to those of the coal. Some figures will be annexed, sketched on the spot, by Mr. George Jones, from which the order and form of the strata will be easily understood.

There are rail roads leading through the mine for the purpose of conveying the coal to the main road, by which it is to pass off to the great rail way leading to the river; and the refuse coal rocks and rubbish are also made to descend in cars, by gravity, to the different points by which such materials are discharged down the side of the mountain. These rail ways are continued over the valleys, and the rubbish being thrown down at the end and on both sides has already formed about a dozen artificial hills, shaped like a very steep roof and terminating almost abruptly in a great descent (hundreds of feet) down the mountain. These cars are guided, each, by one man, who at the proper place steps off, knocks open the end of the car, and thus the load falls.*

Besides the incombustible rubbish, there is small and inferior coal enough here, to supply the fuel of a great city for many years; the pieces are however too small and too much mixed with stone to be worthy of transportation to a distance, but could they be employed in any local manufacture, such as that of bricks or of lime, they would turn to great account.

We were pleased to observe that in the village of Mauch Chunk they employ the small coal in burning lime; it does not choke the

* In some instances the cars have run off from the end of the rail way, and the men who govern them have been thrown down the mountain, but as they fall among loose rubbish the accidents have not proved fatal.

furnace, because the fragments of limestone, being angular and of considerable size, preserve the cavities necessary for ventilation.

As bricks are made abundantly and of such excellent quality near Philadelphia, it is not probable that they could be carried to that city from this distance, but perhaps the time may come when it can be done with advantage, or when they will be needed for towns that will rise in this region. Clay appears to be abundant here and of a good quality, and were it worked up with the refuse anthracite, especially with the dust, as recommended by Dr. Meade,* it might be a source of much advantage.

Two new mines have been recently opened within a mile of the large one: they are very promising in their appearance, and in connexion with that now wrought they present an inexhaustible supply of fuel.

DESCENT FROM THE MINE.

The coal is conveyed to Mauch Chunk village, in wagons running upon the railway. Fourteen of them, containing each one ton and a half of coal, are connected by iron bars, admitting of a slight degree of motion between two contiguous wagons; a single man rides on one of the wagons, and by a very simple contrivance regulates their movement: a perpendicular lever causes a piece of wood to press against the circumference of each wheel on the same side of the car, acting both ways from the central point between them, so that by increasing the pressure, the friction retards or stops the motion, and as all the levers are connected by a rope they are made to act in concert. The traveller is much interested in seeing the successive groups of wagons moving rapidly in procession and without apparent cause; they are heard, at a considerable distance, as they come thundering along with their dark burdens and give an impression of irresistible energy: at a suitable distance follows another train, and thus three hundred tons a day and some days three hundred and forty tons,† are regularly discharged into the boats as already described. At first they descended at the rate of fifteen or twenty

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* Am. Jour. Vol. XVIII. p. 118.

† *One day's work at Mauch Chunk, between Sun rise and half past four P. M.*—Three hundred and forty tons of coal quarried at the Mines, loaded and brought on the rail road, nine miles—unloaded from the wagons down the chute, and loaded into boats. The *boats* for this coal *all built* the same day and within the above mentioned time. Forty thousand feet of lumber sawed in one day and night. They create the freight, and build and load the vessels all on the same day.

miles an hour, but they were obliged to reduce the speed, as it injured the machines, and by agitating and wearing the coal, involved the driver in a cloud of black dust. The empty wagons are drawn back by mules; fourteen wagons to eight mules; twenty eight mules draw up forty two coal and seven mule wagons, and the arrangement is so made that the ascending parties shall arrive in due season at the proper places for turning out. The same is true of the pleasure cars, which are allowed to use the rail way; only they must not interfere with its proper business, and should they do it, it would be at their peril, as they might be crushed by the momentum of the descending wagons. When they happen to be caught out of their proper place, the drivers make all possible haste to remove them out of the rail way track, but they carefully avoid these meetings, and they rarely happen, unless the cars go out of their proper time.

The mules ride down the rail way; they are furnished with provender placed in proper mangers, four of them being enclosed in one pen mounted on wheels; and seven of these cars are connected into one group, so that twenty eight mules constitute the party, which, with their heads all directed down the mountain, and apparently surveying its fine landscapes, are seen moving rapidly down the inclined plane with a ludicrous gravity, which, when observed for the first time, proves too much for the severest muscles.

They readily perform their duty of drawing up the empty cars, but having once experienced the comfort of riding down, they appear to regard it as a right, and neither mild nor severe measures, not even the sharpest whipping, can ever induce them to descend in any other way.

The return of the traveller, in the pleasure cars, is so rapid that it is not easy entirely to suppress the apprehension of danger; we performed the eight miles from the summit in thirty three minutes; should an axle-tree break—an accident which sometimes happens with the coal wagons—it would be impossible that the passengers should escape unhurt, especially in the turnings of the road and in places where trees, rocks and precipices allow no safe place of landing. All danger would however be avoided by checking the motion, so that it should not exceed eight or ten miles an hour and this is easily done in the same way as that practised in the coal waggons. Happily no accident has yet occcurred. It would be prudent at least to require the manager to check the motion of the car at the steepest places; but these are the very situations where he chooses to make a display of cracking his whip and cheering his wheels, instead of his horses, and the increased impulse, given by gravity, as

he relaxes the pressure of the lever, when the car springs forward like spirited horses at the word of their master, makes the illusion almost complete.*

On the whole, whether we regard scenery, science, comfort, amusement, or health, Mauch Chunk may be presented to every intelligent traveller as a point of peculiar attraction and gratification and its extraordinary combination of rare and strange features, grouped in a wild and almost savage spot, partially softened and subdued into civilization and comfort by man, cannot fail to excite and to satisfy an increasing public curiosity.

There is here, a very ample and comfortable public house rendered an agreeable home, by the kindness and intelligence of Mr. and Mrs. Kimball. There are stages to Pottsville situated among the Schuylkill mines and to the Susquehanna and Delaware rivers.

At the Mauch Chunk mine the intelligent stranger is gratified by the urbanity and frankness of Mr. Holland the immediate superintendant, and at Mauch Chunk village, every information may be obtained from the head of the entire establishment for the mines and the navigation, Mr. Josiah White, than whom it would be difficult to find, in any country, a gentleman more perfectly master of his own arduous duties, or more courteous and interesting to the enquiring stranger. His intelligence, perseverance, and energy, have been decisive in securing the success of the company, of which he is the head, whose expenditure of $2,500,000, now places them in a situation to give the fullest effect to their mining operations, and to secure the most extensive market for their invaluable coal. Mr. White states, in a published document, that their rail way alone has saved them $50,000 but that he does not think it economical, on account of the wear and tear, to travel on rail ways faster than six miles an hour with heavy loads, unless with passengers and valuable goods, which will bear heavy tolls, so as to reimburse the expense of repairs, which is of course greater as the motion is more rapid. Still, he is of opinion that a rail road may be constructed sufficiently solid, strong and true to admit of a motion of sixty miles an hour for a short time.—The lockage from Mauch Chunk to Bristol on tide water, is five hundred and twenty four feet, in a distance of one hundred and six miles,

* The proprieter informs us, that the pleasure cars generally do not go so fast as is mentioned in the text; they are carefully and frequently inspected and they are made of a strength which places them beyond the danger of breaking, by ordinary use;—when going at the rate of twenty miles an hour they can be stopped within a distance of fifty or one hundred feet, by the breaks attached to them.

and then eighteen miles to Philadelphia, make the whole distance one hundred and twenty four miles.

The qualities and peculiarities of the coal of the Mauch Chunk mine, commonly called Lehigh coal, are well known. I have given a favorable opinion of it in this Journal, Vol. X. p. 341, and continued experience since, has confirmed my first impressions of its high value in producing an intense and lasting heat, especially in the close drawing or chemical furnace for warming houses and other buildings. For this and similar purposes, the best quality of the Lehigh or Mauch Chunk coal is unrivalled. There are however here as well as in all the mines in the other regions, several varieties of the coal, of different degrees of excellence, depending principally upon the presence or absence of foreign matter, chiefly earthy substances.

Vegetable impressions are rare in the mines in Mauch Chunk.*

NEW MINES.

May 14.—In the afternoon, setting out on our way towards the Susquehanna river, Mr. White conducted us to several new mines which he has recently discovered. We turned around the end of the Mauch Chunk mountain where it abuts upon the Lehigh, and following the course of that river, here a roaring, turbulent, crystal stream, with the mountain range upon our left and the river on our right; after going two miles we deviated and travelled several more upon the flank of the Nesquihoning mountain, which forms a very acute angle with the Mauch Chunk mountain, and is connected with it by a narrow and high valley, so that it may be regarded as one mountain with a double converging ridge. Here on both sides of a natural defile, called Room Run, through which passes a mountain rivulet, Mr. White has, during the present season, discovered several new mines; five of them have been opened and five more have been discovered and two of the latter have been partially opened.

We visited all these places, and it gives me pleasure to state, that the accounts of them, which we have since seen published in the newspapers are perfectly correct. The beds are of the respective thickness of fifty, fifteen, fifteen, twelve and twenty eight feet, making, collectively, one hundred and twenty feet of solid coal; of the five other beds two are stated to afford coal, one fifteen feet and another thirty nine feet; it is thus ascertained, that one hundred and seventy four feet of coal have been added to the resources of the compa-

* *Mauch Chunk*, is the Indian name, and means *Bear Mountain*, as bears are said to have been anciently numerous there and are still found there, occasionly, as well as panthers.

ny, and when the remaining beds shall be perforated there can be no doubt that the entire thickness will exceed two hundred feet,* which is almost three times that of the great mine at Mauch Chunck. From that place these new mines are distant between four and five miles; they are about the same distance from the village of Mauch Chunk, and are all included within a circuit of two or three miles; they open into one defile and will be approached from one rail road.

The discovery of these mines is owing to the sagacity and good judgment of Mr. White, who, reasoning upon the dip and direction of the mines at Mauch Chunk, was led to believe that the continuation of their beds ought to be found here, and his success has given a brilliant confirmation to his prediction, which redounds the more to his honor, as the surface of this region is very much obscured by enormous masses of loose rocks and stones, which, in several places where the coal has been found, so entirely cover the surface with piles of fragments, the fallen ruins of the mountains, that at first view, nothing seems less probable than the discovery of coal beds beneath. The superficial rocks are however of the same fragmentary composition which prevails throughout these coal regions. Most of these mines are situated on declivities very favorable for drainage, and a rail road of very easy construction over a very practicable country, will conduct the coal with great safety and velocity to the company's establishment at Mauch Chunk. This coal appears to be of the first quality and some of it, in the high lustre and perfection of its fracture, exceeds any thing that I have elsewhere seen.

If there could be any doubt before as to the sufficiency of the company's resources (which certainly could never have been the fact upon any rational view) there cannot now be any hesitation in saying that their mines are entirely inexhaustible.† Among some sections of the Lehigh mines taken by Mr. Jones, and which, with a map of the Mauch Chunk mountain, will be appended to these remarks, will be found one illustrating the peculiar formation of the great bed of fifty feet in thickness and of the strata by which it is accompanied. It will be seen that the strata rise in the form of a half ellipse, placed on

* Since the above was written, a letter has been received from Mr. White, in which it is stated that eight beds have been discovered since our visit. These are of 19, 10, 5, 20, 11, 6, 5, and 5 feet, and the aggregate now ascertained in this valley is 240 feet, more than four times the thickness of the great mine at Mauch Chunk.

† So that the old gentleman in a neighboring city, who was unwilling to alter his fire place, because, the coal might be exhausted, and he might have to alter it back again, may now proceed with safety, and rest assured, that the sun and the Pennsylvania anthracite mines, will burn out together.

end, with the curve uppermost, and this, is the form of the mountain of which they are a part.

There is here the most striking appearance that these strata have been raised by a force from beneath, and it is difficult to avoid the conviction that they were also broken at the top; for, at the upper bend of the stratum of coal, there is a huge rock, twenty feet in two of its dimensions and five or six feet in the other, which has been broken off from the roof rock, a graywacke of which it is a part, and fallen in, and the coal seems then to have closed all around and shut it in, on all sides, except, that in one place, on the right hand a little below the top, the rupture is continued to the surface, and that place was then filled and concealed by the loose rubbish and soil, as was also the rock above. It appears to present a strong confirmation of the truth of the suggestions made in the notice of the great mine at Mauch Chunk namely that an upheaving force exerted with vast energy, from below, has bent, dislocated, and broken the strata.

BEAVER MEADOW MINE.

Leaving the Nesquihoning and passing a narrow valley, we now crossed the contiguous Broad Mountain, by a long and rather tedious ascent. We passed near the celebrated Wyoming path, which appears to be still used by foot travellers, as it anciently was by the Indians in their journies from the Lehigh to the valley of Wyoming, on the Susquehanna. This path is so well trodden, that from the Nesquihoning on the opposite side of the valley, two or three miles off, we could distinctly see it winding up the mountain through the evergreen forest trees, there, free from underwood, sparsely scattered, and having tall branchless trunks. This path was once trodden by nations that now tread the earth no more, for, of all the powerful tribes that anciently hunted and warred among these rivers and mountains, not an individual, so far as we could learn, remains. The Creeks, the Cherokees and the Chocktaws will soon follow in their train, and if they find another land, it will be one from whose bourne no Indian will ever return. Night brought us to a solitary house in the midst of a vast mountain morass, reclaimed in part to agriculture and called the Beaver Meadow; doubtless from the ancient ocupation of this region, so appropriate to their habits, by a race of animals, which, like the Indians, always disappear before the dominion of civilized man.

Our humble house, made cheerful by the civility and devotion of a most respectable and intelligent family, gave us a comfortable resting place, and early the next morning, May 15, we made an excursion to the Beaver Meadow coal mine.

It is one mile and a half from the Berwick turnpike road upon which we were travelling from Mauch Chunk to the Susquehanna.

This mine was opened in 1813 and as the title was contested, Mr. Beach of Salem, on the Susquehanna, who claimed it, could not give a clear title till last winter, when he gained the suit, and sold five hundred and fifty acres to Judge Barnes of Philadelphia. A company is about to be formed to carry on the business of the mine. A rail road is in contemplatation either to the Schuylkill or to the Lehigh. If to the latter, it is said that it will be constructed down Beaver creek to the Lehigh, and down this stream to Mauch Chunk; the whole length to be eighteen miles, eleven to the Lehigh and seven down that stream. Active exertions are now making in Philadelphia* to accomplish the object of working this mine and conveying its coal to market. It is well worthy of the effort. The coal is universally regarded as being of the best quality; all persons whom we heard speak of it agreed in that opinion; the appearance of the coal corresponds with that impression, and its burning too, as far as we could judge by limited opportunities of observation. The mine is in the side of a hill; there is no roof or only a very thin one; it is worked, open to the day like a quarry, it is already fairly disclosed, and there is no apparent impediment to obtaining any quantity of the coal that may be desired. The situation of the mine is not however much elevated above the general surface of the country in its vicinity but there is descent enough, as we were assured, to carry off the water. Smiths, it is said, come a great distance to obtain the coal of this mine, because it is so free from sulphur and in every respect so good.

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The remainder of our ride to Berwick upon the Susquehanna twenty two miles, presented nothing more interesting than fine scenery of mountains, valleys and defiles which were particularly conspicuous, as we travelled across the ridges. We passed the Susquehanna upon a good bridge, and pursued our way, up the western bank, to Longshore's ferry. While our carriage was ferried over in the large boat, our little party passed, a mile above, in a skiff, and enjoyed, in a fine afternoon, the splendid scenery, in a great bend of the river, forming to the eye, a fine lake just below the Nanticocke mountain, which here, on the eastern side, comes down to the water's edge. Our ride on the western bank was rendered somewhat inconvenient by the unfinished operations on the great canal, which is destined to connect the valley of Wyoming and ultimately the State of New York with the

* Private letter to the Editor since his return.

Union Canal, and rail road which from Middletown below, will proceed to Philadelphia.

A ride of a few miles brought us, at night fall, to the valley of Wyoming, and the next morning, May 17, its fine river, meadows, hills and mountains, were illuminated by the sun, rising in a cloudless sky, and we found that the beauty and grandeur of the valley had not been exaggerated*.

ART. II.—*Observations on the Coal Formations in the State of New York; in connexion with the great Coal Beds of Pennsylvania*†. From the Transactions of the Albany Institute; *by* AMOS EATON, *Corresponding Member.*

Read March 11, 1830.

There are four distinct coal formations in the United States. First—The genuine Anthracite or glance coal found in the transition argillite; as at Worcester, (Mass.) Newport, (R. I.) also in small quantities in the north and south range of argillite along the bed and banks of the river Hudson. Second—Coal destitute of bitumen, usually called anthracite; but differing greatly in its character from the anthracite found in argillite. It may be called *anasphaltic coal.* This is embraced in a slate rock, being the lowest of the lower secondary series of rocks. This coal formation is equivalent to the greatest coal measures of Europe. But there is always bitumen in a greater or less proportion,‡ though the proportion is often exceedingly small. The principal American localities of this coal hitherto discovered, are in the state of Pennsylvania; as at Carbondale, Lehigh, Lackawaxen, Wilkesbarre, &c. Third—The proper bituminous coal; as at Tioga, Lycoming, &c. This coal is embraced in a slate rock, which is the lowest of the series of upper secondary rocks. The fourth formation has not been found in the state of New York. I refer to the lignite coal, which is found in a very extensive stratum in the state of New Jersey along the south shore of the bay of Amboy.

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* For our observations, while there, I refer to the last No. of this Journal, (Vol. XVIII,) p. 308. The order of time being of no importance, that account, was for reasons of convenience, published first.

† It was accompanied with a demonstative lecture, given at the request of several members of the New York Legislature, while the bill for boring for coal was pending.

‡ I have, repeatedly, distilled different varieties of this coal, without obtaining any bitumen, although, with the exception of the *dry* coal of R. Island, I always obtained abundance of carburetted gas; and the R. Island coal affords this gas, if previously moistened.—*Ed.*

The argillite that contains the anthracite coal is made up of tables or laminæ very highly inclined, whose edges may always be seen at the upper surface of the stratum; and the stratum may be inspected from Canada to Orange county in the state of New York. The beds of anthracite are always interposed between these inclined tables; consequently when anthracite is present in this rock it may be seen at its upper surface. Such is the situation of the beds of anthracite in Worcester and Newport. As all the beds of this mineral in the argillite of the state of New York are exceedingly thin (none of those hitherto discovered exceeding one inch in thickness) we have no good reason to hope for the discovery of extensive beds in that formation.

The prospect of discovering bituminous coal of the third coal formation within the state of New York is equally doubtful, for the following reasons. Mr. C. Van Rensselaer and myself have traced the slate rock which embraces the bituminous coal of Tioga to Seneca and Cayuga lakes, also down those lakes to their outlets. I have traced the same to Lake Erie and continued my examinations more than twenty miles along its southern shore. The same bituminous shale embracing the various bituminous coal which is found in vast beds in Tioga and Lycoming are found in the same continuous rock along the shores of the aforesaid lakes. The thickest of these beds hitherto discovered in the state of New York do not exceed two inches. This carboniferous rock may be inspected to its very base, and is there seen reposing upon a stratum of limestone, which the English call upper carboniferous limestone, for the distance of at least two hundred miles; reckoning both banks of Cayuga and Seneca and the south bank of Erie. The layers of this rock are always horizontal or nearly so, and the great beds of Pennsylvania as well as the thin beds of the state of New York are interposed between these horizontal layers.* Consequently if any thick beds of coal were present along the shores of these lakes they would present themselves to the eye of the most careless observer. As the banks of the Seneca lake together with the walls of the continued ravine from the head of the lake towards Pennsylvania present a profile section of this rock almost across the state, we can desire no better evidence of its character in regard to coal. And the two hundred miles of profile view presented by the almost perpendicular banks of these three lakes, afford evidence of

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* Reference to the papers in the present Volume on the anthracite of the Susquehanna and Lehigh, will show that the strata are more or less inclined and sometimes at a high angle; although occasionally they are nearly horizontal.—*Editor.*

the quantity of coal embraced in this formation equal to the line of borings or any artificial excavations of the same extent to the depth of from fifty to one hundred feet. Deeper borings or other excavations would be of no use; because we now inspect the carboniferous slate rock to its base.

From the preceding statement of facts it appears that all our hopes of discovering valuable coal beds in the state of New York are necessarily limited to the second coal formation in which the coal beds of Pennsylvania, destitute of bitumen, are embraced. It was stated in a preceding part of this paper that the coal beds of Carbondale, &c. were embraced in a slate rock, which is the lowest stratum of the lower secondary series of rocks. Although I have traced this rock from the Pennsylvania coal beds along the foot of Catskill mountains, the Heldebergh mountains, and by the way of Utica to Big Salmon river on Lake Ontario, and observed it, in passing laterally under the rock which contains all the salt springs of the west; yet the importance of this part of my subject demands a more detailed description. The lime rock which extends along the foot of the Catskill mountains is the lower carboniferous lime rock of European geologists. It underlays the slate rock which embraces the Pennsylvania coal beds last mentioned. It supports the same slate rock from the south part of Pennsylvania to Sackett's Harbor on Lake Ontario. It forms a kind of Gothic arch around the southern extremities of two primitive spurs from M'Combs mountains; one called Root's Nose and the other Little Falls Hill. With these two exceptions it forms a pretty uniform curve from near Harrisbugh in Pennsylvania to Sackett's Harbor on Lake Ontario. Throughout its whole extent the same continuous slate rock which embraces the Pennsylvania coal beds reposes immediately on its upper surface. This is the slate rock which Farey calls limestone shale, because it is always slaty and always reposes on limestone. This is the slate rock which embraces all the great coal measures of Europe. I have denominated this rock second graywacke slate.

This slate rock may be seen passing laterally under a conglomerate rock, called millstone grit or rubble stone, from near Little Falls to Lake Ontario; a distance of eighty miles. The conglomerate rock underlays the saliferous rock which forms the floor of all the salt springs of the state. That this slate is co-extensive with the saliferous rock cannot be be doubted; for to doubt would be to overturn every principle of the science founded on analogy.

It now remains to present a summary view of the evidences for and against the prospect of finding coal in large beds beneath the saliferous rock.

First—The same variety of coal which is found at Carbondale, and other coal beds in that range, is found in the same continuous rock along the foot of the Catskill mountains, and in numerous other localities; but the beds are subjected to the same diminution in thickness as mentioned in tracing the bituminous coal formation along the banks of the western lakes: so far this formation presents the same forbidding features. But it must be observed that the saliferous rock does not assume its peculiar characters, such as its marly slate alternations, blue and grey spots, and other variegated lines, &c. further east than the town of Vernon, about twenty miles west of Utica. Here too the salt springs commence, and continue in uninterrupted series to the Niagara river. This same saliferous rock forms the roof of most of the great coal measures of Europe, where it is the floor of the salt mines and springs. Conglomerate rocks, such as that which underlays the saliferous rock in this state, generally accompany the slate rock which embraces the coal.

One of the strongest indications of the presence of coal beneath the saliferous rock, remains to be mentioned. It is the production of carburetted hydrogen gas, which issues from beneath the saliferous rock in various parts of that district. The most easterly point where this gas has been observed, is near the most easterly salt spring which issues from this rock. The spring is near Vernon center, and the place whence the gas issues, is one mile west of Vernon village. The same gas issues from beneath the same rock, at a place called Gasport, six miles east of Lockport, in the bed of the canal, also near the village of Canandaigua, and near Cayuga lake. Several other places have been mentioned, but these have been carefully examined and minutely described. The production of a similar gas is considered by all geologists as referable to no other origin but that of fossil coal. If we are to reason from analogy, we may be justified in venturing an opinion, that borings for coal made near the the places where this gas issues from beneath the saliferous rock, might be attended with success. And it may be added, that if coal should be found beneath the saliferous rock, it would probably be of the bituminous kind, notwithstanding the same slate rock embraces coal destitute of bitumen in the state of Pennsylvania; for the European slate rock, which is equivalent to this, always contains bituminous coal, when similarly situated.

It may be proper to add a few remarks upon the probable depth to which borings must be extended, if search is to be made for coal by that method. The only data from which we can deduce probable conclusions, are, the thickness of the strata to be perforated at their bassetting edges. As all the borings would of course be commenced on the upper surface of the saliferous rock, the thickness of that rock, of the millstone grit, and of the carboniferous slate, would be the measure of the depth to which the perforations must extend. The thickness of these rocks at their bassetting edges, between Little Falls and Lake Ontario, is as follows: The thickness of the saliferous rock averages about ninety five feet—that of the millstone grit about forty feet—that of the carboniferous slate about one hundred and fifty feet—making in the whole two hundred and eighty five feet. But the saliferous rock increases in thickness throughout its whole extent, from its bassetting edge near Little Falls to the Niagara river. The surface of this rock at Gasport is two hundred and seventy four feet higher than the surface of the waters of Lake Ontario. Here it disappears beneath the waters of that lake; and from a consideration of its uniform dip, as far as it can be observed, its under surface must be at the depth of at least one hundred feet below the surface of the lake. Then allowing forty feet for the thickness of the millstone grit, the upper surface of the carboniferous slate will be four hundred and fourteen feet lower than the surface of the saliferous rock at Gasport. If we add one hundred and fifty feet for the thickness of the carboniferous slate rock, the depth of the boring will be five hundred and sixty four feet. It may be stated in round numbers, that a satisfactory examination, to be made by boring, will require that these rocks be perforated to the depth of six hundred feet. By the same mode of calculation, it appears, that if a similar examination be made at the easternmost locality of native carburetted hydrogen gas, which is near Vernon village, the perforation must extend to the depth of about two hundred and fifty feet. All the intermediate perforations will require to be in proportion to their distances from these two extremes, which are about two hundred miles distant from each other. In Europe, shafts are frequently sunk to the depth of from four hundred to six hundred feet for raising coal from a formation equivalent to this.

There is one locality of native carburetted hydrogen gas, which requires particular consideration. It is in the village of Fredonia, county of Chautauque. Here the gas issues from the upper surface

of the slate rock, which embraces the bituminous coal of Tioga; being the third coal formation. It is about eighty feet higher than the surface of the waters of Lake Erie; one hundred and forty feet higher than the saliferous rock at Gasport. If the bituminous coal beds of Tioga extend to this place in considerable thickness, the gas may issue from them. Such beds might be perforated by boring to about one hundred feet. But if the gas issues from the carboniferous slate beneath the saliferous rock, the borings must extend to the depth of at least seven hundred feet.

I confess that these conclusions amount to nothing more than probable hypothesis. I consider the risk of loss too great to be hazarded by any one individual, and that it is a proper subject for legislative aid. And it may be stated, that if coal is not found beneath the saliferous rock, which is more than two hundred miles in extent, it will be truly a geological curiosity which has no parallel on the eastern continent. But we find many deviations in America from the geological maxims which seem to be established in Europe.

Art. III.—*Description of the Laboratory and Lecture Room in the Medical Department of the University of Pennsylvania.* (With a plate.)

The hearth, behind the table, is thirty six feet wide, and twenty feet deep. On the left, which is to the south, is a scullery supplied with river water by a communication with the pipes proceeding from the public water works, and furnished with a sink and a boiler. Over the scullery is a small room of about twelve feet square, used as a study. In front of the scullery and study are glass cases for apparatus. On the right of the hearth two other similar cases, one above the other, may be observed. Behind the lower one of these is the forge room, about twelve feet square; and north of the forge room, are two fire proof rooms communicating with each other, eleven feet square each; the one for a lathe, the other for a carpenter's bench, and a vice bench. The two last mentioned rooms, are surmounted by groined arches, in order to render them secure against fire; and the whole suite of rooms which I have described, together with the hearth, are supported by seven arches of masonry, about twelve feet each in span. Over the forge room is a store room, and over the lathe and bench rooms, is one room of about twenty by twelve feet. In this room there is a fine lathe, and tools.

The space partially visible to the right, is divided by a floor into two apartments lighted by four windows. The lower one is employed to hold galvanic apparatus, the upper one for shelves, and tables, for apparatus, and agents, not in daily use. In front of the floor just alluded to, is a gallery for visitors.

The canopy over the hearth is nearly covered with shelves for apparatus, which will bear exposure to air and dust, especially glass. In the centre of the hearth there is a stack of brick work for a blast furnace, the blast being produced by means of very large bellows situated under one of the arches supporting the hearth. The bellows are wrought by means of the lever represented in the engraving, and a rod descending from it through a circular opening in the masonry.

There are two other stacks of brick work on the hearth against the wall. In one there is a coal grate which heats a flat sand bath, in the other there is a similar grate for heating two circular sand baths, or an alembic. In this stack there is likewise a powerful air furnace. In both of the stacks last mentioned, there are evaporating ovens.

The laboratory is heated not only by one or both of the grates already mentioned, but also by stoves in the arches beneath the hearth, one of these is included in a chamber of brick work. The chamber receives a supply of fresh air through a flue terminating in an aperture in the external wall of the building, and the air after being heated passes into the laboratory at fifteen apertures, distributed over a space of thirty feet. Twelve of these apertures are in front of the table, being four inches square, covered by punched sheet iron. In the hearth there is one large aperture of about twelve by eighteen, covered by a cast iron plate full of holes, the rest are under the table. By these means the hot air is, at its entrance, so much diluted with the air of the room, that an unusually equable temperature is produced, there being rarely more than two degrees of Fahrenheit difference between the temperature in the upper and in the lower part of the lecture room. There are some smaller windows to the south, besides those represented in the engraving. One of these is in the upper story, from which the rays enter at the square aperture in the ceiling over the table on the right. Besides these, are the windows represented in the engraving back of the hearth, and four others in the apartments to the north of the gallery. All the windows have shutters, so constructed as to be closed and opened with facility. Those which belong to the principal windows are hung like

sashes with weights, so that they ascend as soon as loosened, and when the light is again to be admitted, are easily pulled down by cords and fastened. In addition to the accommodation already mentioned, there is a large irregular room under the floor of the lecture room on the eastern side. This is used as a place to stow a number of cumbrous and unsightly articles, which are nevertheless, of a nature to be very useful at times. Also for such purposes, and for containing fuel, there is a spacious cellar under the lecture room and laboratory.

Art. IV.—*Biographical Memoir of Sir* Benjamin Thomson, *Count Rumford; by* Baron Cuvier.*

From the Edinburgh New Philosophical Journal.

Benjamin Thomson, more commonly known by his German title of Count Rumford, was born in 1753, in the English Colonies of North America, at a place then called Rumford, and at present Concord, belonging to the State of New Hampshire. His family, was of English origin, and cultivated some lands there; and he himself has said that he should probably have remained in the humble condition of his parents, had he not in childhood been deprived of the little means they were able to bequeath to him. Thus, like many other literary characters, it was to early misfortune that he owed his subsequent good fortune and celebrity.

His father died young. His mother having married again, he was separated from her by his stepfather; and his grandfather, from whom alone he had any thing to expect, had disposed of all that he possessed in favor of a younger son, and left him in almost complete destitution.

There is nothing more calculated to induce a premature development of intellect than such a condition as this. The young Thomson attached himself to a clergyman of learning, who undertook to prepare him for the mercantile profession, by giving him a smattering of mathematics. But the good minister also spoke sometimes to him of astronomy, and his lessons in that science benefited his pupil more than he had foreseen.

The young man brought him one day the plan of an eclipse which he had traced according to a method which had suggested itself to

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* Read to the Institute of France.

him on reflecting upon his master's discourses. It was found to be singularly accurate, and this success induced him to abandon all for science.

In Europe, the sciences might have afforded him some recompense; but, at that period, there was none in New Hampshire. Fortunately for him, he had obtained from nature what insures a favorable reception at all periods and in all countries, a fine figure, and dignified and gentle manners. They procured for him, at the age of nineteen, the hand of a rich widow; and the poor scholar, at the moment when he least expected, became one of the great personages of the colony.

His good fortune was not of long duration. The discontent which the conduct of the Ministry and Parliament had, for ten years past, so imprudently cherished, now rose to the greatest extremity. The Government resolved on war, and New Hampshire* was destined to be its first seat.

In the night of the 18th April, 1775, the royal troops, marched from Boston, and after having fought a first battle at Lexington, proceeded toward Concord; but, being presently assailed by a furious multitude, were obliged to betake themselves to their garrison. Mrs. Thomson's family was attached to the government by important offices. Her husband, young as he was, had himself received from it some marks of confidence. His personal opinions besides, led him to support the government. Thus it was natural that he should join the ministerial party with all the fervor of his age, and freely participate in its chances. He therefore retired to Boston with the army, and in such haste, that he was obliged to leave at Concord, his wife, who was far advanced in pregnancy. Having afterwards to move from place to place, he never saw her again, nor was it until after a period of twenty years that he met the daughter to which she gave birth a few days after his departure.

It was undoubtedly an evil of not less magnitude to fight against his countrymen; but perhaps he did not view it as such, and that evil we shall only lament, without venturing to impute to him any blame. During the cruel period from which we have just emerged,† when

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* A slight mistake, arising, obviously, from confounding Concord in Massachusetts, where, and at Lexington, in its vicinity, the first blood was shed, in the war of the revolution, with Concord in New Hampshire, which was the only State, that never was entered by the Royal troops during the revolution.—*Ed.*

† The period of the Revolution

almost all the states of Europe saw their citizens serving under opposite colors, each asserted that he was fighting for his country; and the chance of arms itself, which is the universal umpire, has not terminated this kind of contest. Fortunately, honor and fidelity are points respecting which there are no disputes, and in those happy moments, when reason, induced by exhaustion, at length puts an end to the bloody quarrels of nations, honor and fidelity rally all the virtuous and brave.

Mr. Thomson remained firmly attached to the royal government, and served it with courage and address, whether in the field of battle or in the cabinet; but he did not participate in all the mad schemes of some of its partisans. Those against whom he fought always respected him, and of this feeling he received a very honorable proof at the end of the war, when several cities of the United States sent him urgent invitations to return.

It is well known that one of Washington's first exploits was to compel the English troops to evacuate Boston, on the 24th of March, 1776. Mr. Thomson was employed to carry the news of this unfortunate affair to London. Missions of this kind are not generally such as procure rewards; but the prepossessing appearance of the young officer, and the accuracy and the extent of the information which he gave, made a favorable impression on Lord George Sackville, then Secretary of State for the American department, and so celebrated for the misfortunes of his administration. He thought he had made a good acquisition by attaching such a man to his office, and having received abundant proofs of his talents and fidelity, raised him, in 1780, to the important post of under Secretary of State.

This appointment would have been a very advantageous one under a more able minister; but Mr. Thomson soon experienced the most painful feeling that can affect an honorable man, that of the incapacity of his benefactor. The royal army seemed condemned to every kind of misfortune. Public opinion pronounced more decidedly against the ministers. To the reproaches which their imprudence might have merited, calumnies were added, as always happens when men in place are unsuccessful. Mr. Thomson saw himself about to become the object of some of these imputations. He perceived that a desperate cause can only be served with honor by serving it at the peril of one's life, and he returned to the army, where he obtained the command of a division. This was at the commencement of 1782. The English were confined to Charleston, and reduced to a

war of posts. Mr. Thomson reorganised their cavalry, led it in several encounters, and had still such opportunities enough of distinguishing himself in the course of this campaign, that he was appointed to contribute to the defence of Jamaica, then threatened by the combined fleets of France and Spain; but the defeat of Count de Grasse averted the danger, and soon after peace was proclaimed, which put a close to Mr. Thomson's military career.

Nothing could have happened to him so contrary to all his inclinations and hopes of advancement. He was thirty years of age, held the rank of colonel, enjoyed a high degree of reputation, and was ardently attached to his profession. He considered war so peculiarly suited to his genius, that seeing no appearance of it any where excepting between Austria and the Turks, he determined on offering his services to the Emperor. But his good destiny had decided differently from his inclination. When at Munich, on his journey, he found an opportunity of entering into a more advantageous although more pacific service. The ideas of his earlier years revived, and he was soon brought back to the sciences and the application of them, as to his true vocation.

He had never entirely forsaken them. In 1777, at the commencement of his residence in London, he had made curious experiments on the cohesion of bodies. In 1778, he had undertaken others on the force of gunpowder, which procured him admittance into the Royal Society; and in 1779, he had embarked in the English fleet, chiefly with the view of repeating his experiments on a great scale. But, perhaps, amid the distractions of his military station, and even in the leisure of a private condition, he would only have made isolated trials, without a constant object, and without great results. He looked upon the sciences from a new point of view, when he required their assistance in a great military and civil administration. The statesman remembered that he was a natural philosopher and geometrican. His genius had assisted in establishing his credit; he employed his reputation to second his genius; and in this manner each new service that he rendered to the country which had attached him to itself, produced some discovery, and each discovery that he made enabled him to render some new service.

It was the late king who gave Mr. Thomson to Bavaria. The young colonel on his way to Vienna, passing through Strasburg, where the Prince Maximilian de Deux-Ponts, afterwards King of Bavaria, commanded a regiment, presented himself at parade on

horseback, and in his uniform. At this time the whole conversation of the military turned on the American campaigns. It was natural for them to be desirous of hearing an English officer speak on the subject; he was therefore introduced to the prince, when some French officers were present, who had served in the opposite army. The manner in which he described what he had seen, the plans he showed, and the original ideas he threw out, were a proof that Mr. Thomson was a man of no ordinary acquirements; and the prince, knowing that he was to pass through Munich, gave him strong recommendations to his uncle, the reigning elector.

Charles Theodore, who, from being a mere prince of Sulzbacht had become, by the successive extinction of the chief branches of the Palatine house, sovereign of two electorates, was, in many respects, worthy of this favor of fortune. He was a man of intellect and education, and displayed a taste for science, and for all that announced greatness of mind: he encouraged the arts in his dominions, built beautiful palaces, and founded the Academy of Manheim. If he did not adopt in his government those maxims of philanthropy and toleration which now prevail in the counsels of princes, it is to be attributed to the epoch in which he received his education, an epoch in which Louis XIV passed in Germany for the model and ideal of a perfect monarch. We have already said, and we shall see still more plainly in the sequel, that Mr. Thomson's ideas were much of the same nature. He could not therefore fail to esteem the Elector, nor the Elector him; and, in fact, after the first interview, he received the offer of an appointment, and resolved to have no other master.

He travelled, therefore, rapidly to Vienna, and hastened to return to London, to obtain permission to enter into the service of Bavaria. This was granted to him, with flattering marks of satisfaction on the part of his government. The king knighted him, and allowed the half-pay belonging to his rank, which he retained till the period of his death.

To the accomplishments and external advantages of which we have spoken, and the circumstance of his being an Englishman, which is always so great a recommendation on the continent, Sir Benjamin Thomson (for it was with this title that he returned to Munich in 1784) added a talent for pleasing, which could hardly have been anticipated in a man that had issued, as it were, from the forests of the new world. The elector, Charles Theodore, granted

him the most marked favor: he made him successively his aid-de-camp, his chamberlain, member of his council of state, and lieutenant-general of his armies. He procured for him the decorations of the two orders of Poland, because the statutes of those of Bavaria did not then permit his admission to them. Lastly, in the interval between the death of the Emperor Joseph and the coronation of Leopold II., the Elector took advantage of the right which his functions, as vicar of the empire, gave him, to raise Sir Benjamin to the dignity of Count, by the name of the district of New Hampshire in which he was born.

Count Rumford has sometimes been blamed for the importance which he seems to have attached to distinctions, to which his real merit might have rendered him indifferent. They who have done so, however have not sufficiently considered this situation. Formerly, a title without birth was of no estimation among us; but it is not so in England, where the title, as it were, metamorphoses the man, or in Germany, where one seldom receives a great office without at the same time, receiving a corresponding title. Count Rumford, therefore, might think this custom necessary for the maintenance of a respect which he knew how to render so useful. We have besides seen, by a recent experiment made on the great scale, that some not being philosophers enough to refuse titles when chance offered them and others being apparently too much so to think that titles were worth the trouble of being refused, every body accepted them. We do not therefore condemn Count Rumford for having done like all the world; we even pardon beforehand those who may imitate him in this respect, provided they imitate him in other respects also.

His new master not only procured honorable distinctions for him, but also confided to him a real and very extensive power, by uniting in his person the administration of war and the direction of the police; and his reputation, besides, soon gave him a great influence over all parts of the government.

Most of those who have been led to power by the course of events, arrive there already misled by public opinion; they know that they will infallibly be called men of genius, and that they will be celebrated in prose and verse, if they succeed in changing in some point the forms of the government, or extending a few leagues the territory in which this government is exercised. Is it therefore surprising, that internal commotions and external wars incessantly disturb the repose

of men? It is to themselves that men ought to look. Fortunately for Count Rumford, Bavaria could not at this period hold out these temptations to her ministers. Her constitution was fixed by the laws of the empire, her frontiers by the great powers that surrounded her; and she was reduced to the condition, which most states find so hard, of confining all her cares to ameliorating the condition of her people.

It is true that she had much to do in this respect. Her sovereigns, enriched at the period of the religious wars, in consequence of their zeal for catholicism, had long carried the marks of this zeal far beyond what an enlightened catholicism requires; they encouraged devotion, and did nothing for industry; there were more convents than manufactories in their territories; the army was almost reduced to nothing; ignorance and idleness predominated in all classes of society.

Time does not permit us to mention all the services which Count Rumford rendered to this country and its capital, and we are obliged to limit ourselves to a few of the more remarkable.

He first ocupied himself with the army, in the organization of which, a peace of forty years had allowed gross abuses to be introduced. He found means of removing the soldier from the ill-treatment of officers, and of adding to his comfort at the same time that he diminished the expenses of the state. The equipment of the troops, their clothing and head-dress, became more suitable and more convenient. Each regiment had a garden, where the soldiers themselves reared the vegetables which they required; and a school in which their children received the elements of education. The military discipline was simplified; the soldier was brought nearer to the citizen; the privates had more facilities afforded them of becoming officers; and a school was at the same time established, in which young men of family might receive the most extensive military education. The artillery, as being more connected with the sciences, chiefly attracted the regard of Count Rumford, who made numerous experiments for its improvement. Lastly, he established a workhouse, in which were manufactured, with regularity, all the articles necessary for the troops—a house which, at the same time, became in his hands a source of improvement in the police still more important than those which he had introduced in the army.

After what we have said of the state of Bavaria, it will be easily conceived that mendicity must there have become excessive; and it was in fact asserted, that, next to Rome, Munich had the greatest number of beggars of any city in Europe. They obstructed the

streets, divided the stations among each other, sold or inherited them as one does a house or a farm. Sometimes they were even seen to fight for the possession of a post or church-door; and, when opportunity presented, they did not refuse to commit the most revolting crimes.

It were easy to find by calculation that the regular support of this mass of wretches would cost the public less than the pretended charities which they extorted from it. Count Rumford had no difficulty in perceiving this; but he saw, at the same time, that to extirpate mendicity, something more was necessary than to prohibit it; that but half of the work would be done by arresting the mendicants and feeding them, unless their habits were changed, unless they were formed to industry and order, and unless there were inspired into the people a horror of idleness, and of the lamentable consequences which it induces.

His plan, therefore embraced physics and morals. He pondered it long, proportioned all its parts to each other, and to the laws and resources of the country; prepared with vigor and in secret the details of its execution, and, when all was ready, directed it with firmness.

On the first of January, 1790, all the beggars were led to the magistrates, and it was signified to them that they would find in the new workhouse whatever was necessary for their subsistence, but henceforth they were prohibited from begging.

In fact, there were provided for them materials and tools, large and well heated rooms, wholesome and cheap food. Their work was paid by the piece. At first it was imperfect, but they soon improved. The workmen were classed according to their progress, which also facilitated the arrangement of the products. Their employment was to produce clothing for the troops. At the end of some time there was an overplus, which was sold to the public, and even to other countries, so that ultimately there was an annual profit of upwards of ten thousand florins secured to the state.

The whole establishment was, at the commencement, amply supported by voluntary subscription, in which all classes of the inhabitants were made to feel interested, and which was much inferior to the sum of the alms that were formerly given.

And to change in this manner the deplorable condition of a degraded class, nothing was required but the habit of order and judicious management. Those wild and distrustful beings yielded to the dis-

positions that were manifested to promote their well being. It was, says Count Rumford himself, by rendering them happy that they were taught to become virtuous. Not even a child received a blow. Still more, the children were at first paid merely for looking on the work of their companions, and they soon came weeping to implore that they also should be set to work. Some praises properly bestowed, some handsomer dresses, recompensed good conduct, and excited emulation. The spirit of industry was roused by self-love, for the springs of the human heart are the same in the most opposite conditions, and the equivalent of a cordon of nobility exists even in the lowest grades of society.

It was not, however, the medicants alone whose condition was ameliorated. The bashful and honest poor were also admitted to ask work and food. More than one woman of rank that had fallen into misfortune, obtained flax and soup from the commissioners, without being ever questioned, and among the brave of the Bavarian army, there were many who wore clothes that had been spun by a noble and delicate hand.

The success was such that not only were the poor completely succored, but their number was greatly diminished, because they learned to support themselves. In one week two thousand five hundred had been registered, and some years after they were reduced to fourteen hundred. They even learned to feel a sort of pride in relieving their old companions; and nothing prevented better their asking alms, than having enjoyed the pleasure of bestowing them.

Although Count Rumford had been directed in his operations more by the calculations of a politician than by the impulses of a man of feeling, he could not help being truly moved at the sight of the change which he had effected, when he beheld on those countenances, formerly shrivelled by misfortune and vice, an air of satisfaction, and sometimes even tears of tenderness and gratitude. During a dangerous illness he heard a noise under his window, of which he inquired the cause. It was a procession of the poor who were going to the principal church, to implore of heaven the safety of their benefactor. He confessed himself that this spontaneous act of religious gratitude, in favor of a person of another communion, appeared to him the most affecting of recompenses; but he did not dissemble that he had obtained another, which will be more lasting. In fact it was in laboring for the poor that he made his most important discoveries.

M. de Fontenelle said of Dodard, who, in rigorously observing the fasts prescribed by the Church, made accurate experiments on the changes which his abstinence produced in him, that he was the first who had taken the same path for getting to heaven and the academy. Count Rumford may be associated with him, if, as may be believed, the services rendered to men lead to heaven as surely as the practices of devotion. This much is certain, however, that it was to his benevolent schemes that he was indebted for the glory which his name will possess in the history of physics.

Every one knows that the object of his finest experiments was the nature of heat and light, as well as the laws of their propagation; and in this, what interested him was, to know how to feed, clothe, warm, and light with economy, a great assemblage of men. He first engaged in comparing the heat of different kinds of clothes. This, as is well known, is not an absolute heat, and we only mean by it the property of retaining that which is generated by our bodies, and of preventing its dissipation. Count Rumford enveloped thermometers raised to a higher temperature than the air with various substances, and observed the time they took in returning to a state of equilibrium. He arrived at this general result, that the principal retainer of heat is the air between the fibres of substances, and that these substances furnish clothes so much the warmer, the more they retain the air heated by the body. It is thus, and it will not fail to be remarked, that Nature has taken care to clothe the animals of cold countries.

Passing then to the examination of the most effectual means of economising fuel, he saw in his experiments that flame in the open air gave little heat, especially when it was not rapidly agitated, and did not strike vertically the bottom of the vessel. He also observed that the vapor of water conduced very little to heat when it was not in motion. Chance gave him the key of these phenomena, and opened up to him a new path of inquiry. Casting his eyes on the colored liquor of a thermometer, which was cooling in the sun, he perceived in it a constant motion, which continued until the thermometer had fallen to the surrounding temperature. Some powders which he diffused in liquids of the same specific gravity, were also agitated whenever the temperature of the liquid changed, a circumstance which announced currents in the liquid itself. Count Rumford came to think that it was precisely by this transportation of molecules that the heat was distributed in the liquids, which by themselves would have allowed very little caloric to pass. Thus, when the heating

commences below, the warm molecules, becoming lighter, ascend and the cold molecules are precipitated to the bottom to be heated. This he verified by direct and ingenious experiments. So long as only the upper part of the column of liquid was heated, the lower did not in any degree partake of the heat. A piece of red hot iron plunged in oil to a short distance from a bit of ice which lay at the bottom, did not melt a particle of it. A bit of ice kept under boiling water was two hours in melting, while at the surface it melted in three minutes. Whenever the internal motion of a liquid was arrested by the interposition of some non-conducting substance, the cooling or heating, in a word, the equilibrium, was retarded in it. Thus feathers or hair would produce the same effects in water as in air.

As it is known that fresh water is at its maximum of density at seven degrees above the freezing point, it becomes lighter a little before freezing. It is for this reason that ice always forms at the surface, and that once formed, it preserves the water which it covers. Count Rumford found in this property the means by which nature preserves a little fluidity and life in the countries of the north; for, if the communication of heat and cold took place in fluids as in solids, or only in fresh water as in other liquids, the streams and lakes would quickly be frozen to the bottom.

Snow, on account of the air which is mingled with it, was, in his eyes, the mantle which covers the earth in winter, and prevents it from losing all its heat. He saw in all this distinct precautions of Providence. He saw the same in the property which salt water possesses, the reverse of that of fresh water, by which, at all degrees of temperature, its molecules are precipitated when they are cooled; so that the ocean, being always temperate at its surface, softens the rigor of the winters along the shores, and warms again, by its currents, the polar climates, at the same time that it cools those of the equator.

The interest of Count Rumford's observations, therefore, extended, in some measure, to the whole economy of nature in our globe, and perhaps he made as many cases of those relations to them which he perceived in general philosophy, as of their utility in public and private economy.

Their mere announcement must have made my hearers anticipate this utility; and, besides, there is no one who does not know their effects from experience. It was by a regular application to these discoveries, that Count Rumford constructed fire-places, furnaces,

and caldrons of new forms, which, from the hall to the kitchen and the workshop, have reduced the consumption of fuel by more than a half.

When we fancy to ourselves those enormous chimneys of our ancestors, in which whole trees were burnt, and which almost all smoked, we are astonished that the simple and sure improvement of Count Rumford was not sooner devised. But there must be some difficulty concealed in all those things which are found out so late, and which we call so simple when once they are discovered.

The improvements which Count Rumford made in the construction of kitchens, will have a more important, although a somewhat more tardy result, because somewhat more firm foundations must be be laid for their first establishment. The unfortunate cook himself, at present half roasted by the heat of his fire, will be enabled to operate calmly in a mild atmosphere, with an economy of three fourths for fuel, and of one half for time: and Count Rumford did not consider as of small importance this ease procured for those who prepare our food. As the same quantity of original matter furnishes a much greater or a much smaller quantity of nutrition, according as it is prepared, he looked on the art of cookery as equally interesting with that of agriculture. He did not confine himself to the art of cooking food at little expense, but also bestowed much attention on that of composing it. He discovered, for example, that the water which is incorporated with food becomes itself, by this mixture, a nutritive matter; and he tried, of all the alimentary substances, to find out that which nourishes most and at the smallest expense. He even made a study of the pleasure of eating, on which he wrote an express dissertation; not assuredly for himself, for his moderation was excessive, but in order also to discover the economical means of increasing and prolonging it, because he saw in it an intention of nature to excite the organs which are to concur in digestion.

It was by thus judiciously combining the choice of substances, with all possible economy in the art of preparing them, that he was enabled to support man at so little cost, and that, in all civilized countries, his name is now connected with the most efficacious aids that industry can receive. This honor much excels those which have been decreed to the Apiciuses of ancient and modern times; I would even venture to say, to many men who have been celebrated for discoveries of a higher order.

In one of his establishments at Munich, three women were sufficient to prepare a dinner for a thousand persons, and they burnt only ninepence worth of fuel. The kitchen which he constructed in the Hôpital de la Pièta at Verona, it still more perfect, there being burnt in it only the eight part of the wood which was formerly consumed.

But it was in the employment of steam for heating, that Count Rumford, so to speak, surpassed himself. It is known that water kept in a vessel which it is unable to burst acquires an enormous heat. Its vapor, at the moment when it is let loose, carries this heat wherever it is directed. Baths and apartments are thus heated with wonderful quickness. Applied to soapworks, and especially to distilleries, this method has already enriched several manufacturers of our southern departments; and in the countries where new discoveries are more slowly adopted, it has offered immense advantages. The brew-houses and distilleries of England are heated in this way. In them a single small copper caldron boils ten large wooden vats.

Count Rumford went so far in his improvements as even to economise all the heat of the smoke, which he only allowed to issue from his apparatus after it had become almost perfectly cold. A person justly celebrated for the elegance of his mind, said to him that he would soon cook his dinner with his neighbor's smoke. But it was not for himself that he sought economy. His varied and often repeated experiments, on the contrary, cost him much, and it was only by dint of lavishing his money, that he taught others to save theirs.

He made nearly as many researches on light as on heat, and among his results, the following observations are principally worthy of notice; that flame is always perfectly transparent and permeable to the light of any another flame; that the quantity of light is not in proportion to that of the heat, and that it does not depend, like the latter, upon the quantity of matter burnt, but rather upon the vivacity of the combustion. By combining these two observations, he invented a lamp with several parallel wicks, the flames of which mutually exciting each other, without allowing any of the rays to be lost, are capable of producing an unlimited mass of light. It is said that when it was lighted at Auteuil, it so dazzled the lamp-maker who had constructed it, that the poor man was unable to find his way home, and was obliged to pass the night in the wood of Boulogne.

I deem it superfluous to mention how he varied and adapted to all sorts of uses the different instruments that are employed for lighting.

The Rumford lamps are not less diffused nor less popular than the chimneys and soups of the same name. This is a true character of a good invention.

He determined, by physical experiments, the rules that render the oppositions of color agreeable. Few fine ladies imagine the choice of a border, or of the embroidery of a ribbon, depends on the immutable laws of Nature, and yet such is the fact. When one looks steadily for some time at a spot of a certain color on a white ground, it appears bordered with a different color, which, however, is always the same with relation to that of the spot. This is what is called the complementary color; and, for reasons which it were needless to develope here, the same two colors are always complementary to each other. It is by arranging them that harmony is produced, and the eye flattered in the most agreeable manner. Count Rumford who did every thing by method, disposed, according to this rule, the colors of his furniture, and the pleasing effect of the whole was remarked by all who entered his apartments.

Continually struck, in all his labors, by the wonderful phenomena of heat and light, it was natural for him to attempt a general theory respecting these two great agents of nature. He considered them both as only effects of a vibratory motion impressed on the molecules of bodies, and he found a proof of this in the continual production of heat which takes place by friction. The boring of a brass gun, for example, putting water in a short time into a state of ebullition, and this ebullition lasting as long as the motion which produced it, he found it difficult to conceive how, in such a case, matter was disgaged, for it would require to be inexhaustible.

He moreover proved, better than any person, that heat has no weight. A phial of spirit of wine, and another of water, remained in equilibrium after the congelation of the latter, although it had lost by this, caloric enough to raise the same weight of gold to a white heat.

He invented two singularly ingenious instruments. The one, which is a new Calorimeter, serves to measure the quantity of heat produced by the combustion of a body. It is a box filled with a given quantity of water, through which the product of the combustion is made to pass by a serpentine tube; and the heat of this product transmitted to the water, raises it a determinate number of degrees, which serves as a basis to the calculations. The manner in which he prevents the external heat from altering his experiment, is

very simple and ingenious. He commences the operation at some degrees below that heat, and terminates it at as many degrees above it. The external air resumes, during the second half, precisely what it had given out during the first. The other instrument serves to disclose the slightest differences in the temperature of bodies, or in the facility of its transmission. It consists of two glass balls filled with air, connected by a tube, in the middle of which is a bubble of colored spirit of wine. The smallest increase of heat in one of the balls drives the bubble toward the other. This instrument chiefly, which he named a Thermoscope, made known to him the varied and powerful influence of different surfaces over the transmission of heat, and also pointed out to him numerous methods of retarding or acceleratng, heating or cooling at will.

These two last kinds of researches, and those which have reference to illumination, ought to interest us more particularly, because he had made them after he had fixed his residence at Paris, and taken an active part in all our occupations. He considered them as his contributions in quality of a member of the Institute.

Such are the principal scientific labors of Count Rumford, but they are far from being the only services which he rendered to science. He knew that, in discoveries, as in philanthropy, the work of an individual is transitory and limited, and, in the latter, as in the former, he strove to establish durable institutions. Thus he founded two prizes, which were to be annually assigned by the Royal Society of London, and the Philosophical Society of Philadelphia,* to the author of the most important experiments on heat and light; an endowment by which, in evincing his zeal for natural philosophy, he also testified his respect for his native and for his adopted country, and proved, that, by having served the one, he had not quarrelled with the other.

He was the principal founder of the Royal Institution of London, one of the best contrived establishments for hastening the progress of science and its application to the arts. In a country where every individual prides himself on encouraging whatever can be of service to the community, the mere distribution of his Prospectus brought him considerable funds, and his activity would soon have led to its execution. The prospectus itself was already a sort of description, for he

* The American Academy of Arts and Sciences of Boston.—*Ed.*

spoke in it of what he proposed as of a thing in a great measure realized. A vast house presented all kinds of trades and machines in action; a library was formed in it; a beautiful ampitheatre was constructed, in which were delivered lectures on chemistry, mechanics, and political economy. Heat and light, the two favorite subjects of Count Rumford, and the mysterious process of combustion, which puts them at the disposal of man, were to be continually submitted to examination.

This Prospectus is dated at London the 21st January, 1800, and the foundation of the Royal Institution was the work of fifteen succeeding months which Count Rumford passed in England, with the hope of settling there.

After having been loaded, during fourteen years, by the Elector Charles Theodore, with proofs of an always increasing favor, after having received from him, at the period of the famous campaign of 1796, the difficult trust of commanding his army, and of maintaining the neutrality of his capital against the two great powers that seemed equally anxious to attack it, Count Rumford obtained from him as a final recompense, in 1798, the post which he most desired, that of Minister Plenipotentiary at the Court of Great Britain.

There could be nothing more flattering to him in fact than to be enabled to return among his countrymen, and, according to the noble expression of an ancient, to combine leisure with dignity. But his hopes were frustrated. The usage of the English government does not permit, that a man born its subject should be accredited to it as the representative of another power, and the minister for foreign affairs signified to Count Rumford, that it was resolved not to deviate from this usage.

A still more acute disappointment soon after befel him. He was informed of the death of the Prince, his benefactor, which happened in 1799, and he foresaw that he would have no less difficulty in resuming his old than in exercising his new functions. In reality, the Elector Joseph Maximilian was neither ignorant of his merit nor of his services, and remembered that he was the first author of his fortune; but, with a different system of government, and opposite political interests, it was natural that he should have other counsellors than his predecessor, and Count Rumford was not of a character to enter into partnership. Besides, the happy changes which he had effected, had rendered him less necessary, and his views, which had been so useful when Bavaria required to be enlightened,

were no longer such as suited, precisely because the success of their adoption had already been so rapid.

He threfore only returned to Munich for a short time, during the peace of Amiens; and yet even in this short time, he performed a true and great service to science, in contributing, by his advice, to the reorganization of the Bavarian Academy, on a plan which, with utility, in every respect, combined a truly royal magnificence.

The period at length arrived when a final retreat had become necessary. It was no mean honor for France, that a man who had enjoyed the consideration of the most civilized countries of the two worlds, preferred it for his last residence. He preferred France, because he quickly perceived it to be the country where merited reputation most surely gains a true dignity, independent of the transitory favor of courts, and of all the chances of fortune.

In fact, we have seen him among us for ten years, honored by Frenchmen and foreigners, esteemed by the friends of science, participating in their labors, aiding with his advice even the meanest artizans, nobly gratifying the public with a constant succession of useful inventions.

Nothing would have been wanting to his happiness, had the amenity of his behavior equalled his ardor for public utility. But it must be acknowledged, that he manifested, in his conversation and in his whole conduct, a feeling which must appear very extraordinary in a man so uniformly well treated by others, and who had himself done so much good. It was without loving or esteeming his fellow creatures, that he had done them all these services. Apparently the vile passions which he had observed in the wretches committed to his care, or those other passions, not less vile, which his good fortune had excited among his rivals, had soured him against human nature. Nor did he think that the care of their own welfare ought to be confided to men in common. That desire which seems to them so natural, of examining how they are ruled, was in his eyes but a factitious product of false knowledge. He had nearly the same ideas of slavery as a planter, and he considered the Chinese government as the nearest to perfection; because, in delivering up the people to the absolute power of men of knowledge alone, and in raising each of these in the hierarchy, according to the degree of his knowledge, it made in some measure so many millions of hands the passive organs of the will of a few good heads;—a doctrine which we mention without in any degree pretending to justify it, and which we know to be little adapted to the ideas of European nations.

Count Rumford himself experienced, more than once, that it is not so easy in the west as in China, to engage other men to be nothing but hands; and yet no one was so well prepared as he to make good use of the hands that might be submitted to him.

An empire, such as he conceived, would not have been more difficult for him to manage, than his barracks and poor-houses. For this he trusted especially to the power of order. He called order the necessary auxiliary of genius, the only possible instrument of real good, aud almost a subordinate divinity regulating this lower world. He purposed to make it the subject of a work which he thought would be more important than all that he had written; but of this work there were found among his papers only a few unconnected materials. He himself, in his person, was, in all imaginable points, a model of order. His wants, his pleasures, and his labors, were calculated, like his experiments. He drank nothing but water, and ate only fried or roasted meat, because boiled meat, in the same bulk, does not afford quite so much nutriment. In short, he permitted in himself nothing superfluous, not even a step or a word, and it was in the strictest sense that he took the word *superfluous*.

This was no doubt a sure means of devoting his whole strength to useful pursuits, but it could not make him an agreeable being in the society of his fellows. The world requires a little more freedom, and is so constituted that a certain height of perfection often appears to it a defect, when the person does not take as much pains to conceal his knowledge as he has taken to acquire it.

Whatever Count Rumford's sentiments were with respect to men, they diminished nothing of his respect for the Divinity. In his works, he neglected no opportunity of expressing his religious admiration of Providence, and of offering to the admiration of others the innumerable and varied precautions of Providence for the preservation of his creatures. Perhaps even his system of politics was derived from the circumstance of his imagining that princes ought to act in like manner, and take care of their subjects, without being accountable to them.

This rigorous observance of order, which probably marred the pleasure of his life, did not contribute to prolong it. A sudden and violent fever carried him off, in his full vigor, at the age of sixty-one. He died on the 21st August, 1814, in his country house at Auteuil, where he passed the summer.

The notice of his obsequies arriving only at the same time with the news of his death, did not allow his fellow members to perform the accustomed honors at his tomb. But if such honors, if any efforts to extend renown and render it durable, were ever superfluous, it would be for the man who, by the happy choice of the subjects of his labors, had richly earned the esteem of the learned, and the gratitude of the unfortunate.

Art. V.—*On Central Forces; by* Prof. Theodore Strong.

(Continued from Vol. XVII. p. 73, of this Journal.)

I have proved at pages 72, 73, of the Journal for October, 1829, that the value of F in the case of a particle of matter describing a conic section, about a centre of force at the focus, is $\frac{C'^2}{r^2p'}$: hence conversely, supposing the same notation, and that $F=\frac{A}{r^2}$, (A=const.) the nature of the curve described is easily found. For assume $\frac{C'^2}{p'}=A$, then $p'=\frac{C'^2}{A}$ is found; $\therefore F=\frac{C'^2}{r^2p'}=-\frac{C'^2}{2}\frac{d\left(\frac{2}{rp'}\right)}{dr}$; but the general form of F given at page 72 is $F=-\frac{C'^2}{2}\frac{d\left(\frac{1}{r^2\sin.^2\psi}\right)}{dr}$; hence, by comparing these values of F, I have $d\left(\frac{1}{r^2\sin.^2\psi}\right)=d\left(\frac{2}{rp'}\right)$, or by integration $\frac{1}{r^2\sin.^2\psi}=\frac{2}{rp'}-\frac{1}{ap'}$ (1), ($-\frac{1}{ap'}$=the arbitrary constant.) (1) is the general equation of the conic sections, p'= the semi-parameter, a= the semi-transverse axis, r= the distance of any point of the curve from the focus, and $r\sin.\psi$= the perpendicular from the focus to the tangent at that point, and it is evident that the centre of force is at the focus. By (1) I have $\frac{1}{ap'}=\frac{2}{rp'}-\frac{1}{r^2\sin.^2\psi}$ (2); let r' and ψ' denote the given values of r and ψ

at the origin of the motion, then by substituting these values in (2) $\frac{1}{ap'}$ is found, and it is evident by (7), (8), (9), given in Vol. XVII. page 72, that if $\frac{1}{ap'}$ is positive, the curve is an ellipse; if $\frac{1}{ap'}=0$, it is a parabola; but if $\frac{1}{ap'}$ is negative, it is an hyperbola; or since p' is a given positive quantity, the curve is an ellipse, if a is positive; a parabola, if $\frac{1}{a}=0$, or $a=$ infinity; and an hyperbola, if a is negative. I have thus far supposed A to be positive, or the central force to be centripetal; but should A be negative, or the force centrifugal, the signs of the terms involving p' in (1) are to be changed, and it becomes $\frac{1}{r^2 \sin.^2\psi}=\frac{1}{ap'}-\frac{2}{rp'}$ (3); which is the equation of an hyperbola, which shows that the particle is moving in one of the hyperbolas, and is acted upon by a centrifugal force situated in the focus of the opposite hyperbola. (1) is easily changed to $(2ar-r^2)$ $\sin.^2\psi=ap'$ (4); substitute for $\sin.^2\psi$ its equal $\frac{1-\cos.2\psi}{2}$, then multiply both sides of the equation by 4, and there results $(2a-r)\times(2r-2r\cos.2\psi)=2a\times 2p'$, or $2a:2a-r::2r-2r\cos.2\psi:2p'$ (5); (5) agrees with Newton's proportion, (Prin. book I. sec. iii. prop. 17,) for in his figure, $2a=\mathrm{SP}+\mathrm{PH}$, $2a-r=\mathrm{PH}$, $-2r\cos.2\psi=2\mathrm{SP}.\sin.\mathrm{PSK}=2\mathrm{PK}$, $2r=2\mathrm{SP}$, $2p'=\mathrm{L}$.

But Newton's 17th proposition admits of another very simple construction. For suppose L or $2p'$ to be found, (see his figure,) then cut off on the line SP, from P towards S, a distance $=p'$; through the point of section erect a perpendicular to SP, also draw a perpendicular to the tangent through the point of contact P, and these perpendiculars will intersect at a point in the axis; hence a straight line drawn through S, and the intersection of the perpendiculars gives the position of the axis, and PH will intersect the line thus drawn at the other focus H of the conic section, except in the parabola, when PH will be parallel to the axis; hence every thing else sought in the problem is readily found. The proof of this construction is easy, (see fig. 2 to plate 4, prop. 11, Prin.) admitting what has been proved in prop. 11, we have $\mathrm{PE}=\mathrm{AC}$, suppose PF cuts the axis in x, then $\mathrm{PF}\times\mathrm{P}x=\mathrm{CB}^2$ (Vince's Con. Sec. ellipse, prop. 15,)

$=AC\times p'$, the length p' being cut off from P towards H on the line PH (produced if necessary,) let y denote the point of section, let the perpendicular through y to PH intersect PF in z; then since PF bisects the angle EPH, the triangles EPF, yPz are similar, hence the proportion PE : PF : : Pz : Py or AC : PF : : Pz : p' $\therefore$ AC $\times p'=$ PF $\times$ Pz, but AC $\times p'=$ PF $\times$ Px, hence P$x=$Pz, or the points x and z coincide, and the perpendiculars PF, yz intersect at a point in the axis; a similar demonstration is applicable to the parabola and hyperbola. Again, by using the same figure, and supposing the centre of force to be at H, P being the place of the particle at any time, and PH being denoted by r; let $v=$ the angle PHA $=$ the angle made by r and the perihelion distance HA; then v is easily found by the above construction. For the right-angled triangle Hxy gives $\cos. v=\frac{Hy}{Hx}=\frac{p'-r}{Hx}$; but since P$x$ bisects the angle SPH, (Euc. 6. 3.) SP+PH : SH : : r : Hx; put $\frac{SH}{SP+PH}=e$, then H$x=er$, $\therefore \cos. v=\frac{p'-r}{er}$ (5); (see Mec. Cel. Vol. I. p. 191.) By substituting in (1) for p' its equal $\frac{C'^2}{A}$, it becomes $\frac{C'^2}{r^2 \sin.^2\psi}=V^2=A\times\left(\frac{2}{r}-\frac{1}{a}\right)$ V $=$ the velocity, let V$'=$ the velocity of a particle describing a circle at the distance r from the centre of force, then $F=\frac{A}{r^2}=\frac{V'^2}{r}$; hence $A=rV'^2$ $\therefore V^2=V'^2\times\left(2-\frac{r}{a}\right)$, or $\frac{r}{a}=2-\frac{V^2}{V'^2}$ (6).

It is evident by (6), and by what has been previously shown, that the curve described by the particle is an ellipse, if $2-\frac{V^2}{V'^2}$ is positive; a parabola, if it $=0$; but an hyperbola, if it is negative. These results are manifestly the converse of cor. 7, prop. 16, sec. iii. b. I. Prin. (See also Mec. Cel. Vol. I. p. 190.) Again, by substituting in $p'=\frac{C'^2}{A}$ for C'^2 and A their equals $V^2r^2 \sin.^2\psi$ and rV'^2 it becomes $p'=\frac{V^2}{V'^2}r \sin.^2\psi$ (7). At the aphelion or perihelion, $\sin.\psi=1$ and $p'=\frac{V^2}{V'^2}r$ (8); hence $2p'$: $2r$: : V^2 : V'^2; this proportion agrees with Newton's cor. 2, prop. 17, (supposing that the velocities V, V$'$ at the aphelion, and the aphelion distance r are known.)

By substituting in (5) for p' its value as given by (7), it reduces to $\cos. v = \frac{\frac{V^2}{V'^2} \sin.^2 \psi - 1}{e}$ (9); at the perihelion $\cos. v = 1$, $\sin. \psi = 1$, $\therefore e = \frac{V^2}{V'^2} - 1$ (10); hence if V and V′ are known at the perihelion, the conic section is given in species, for $e =$ the eccentricity divided by the semi-axis; at the aphelion $\cos. v = 1$, $\sin. \psi = 1$, hence $e = 1 - \frac{V^2}{V'^2}$ (11); $\therefore$ by knowing V and V′ at the aphelion the conic section is given in species as before. If the particle should receive a new velocity at any given point of its course, by means of an impulse which acts in a direction that makes given angles with r and the tangent to its course at the point of impulse; then by compounding the velocity of the particle in its orbit at the moment of impulse with the velocity of impulse, the new velocity with which the particle will move becomes known both in magnitude and direction; hence ψ, the angle made by r, and the direction of the velocity thus found becomes known, also V′ remains the same after the impulse as before; hence substitute in (7) for ψ and V the new angle and velocity found as stated above, and p', the new semi-parameter becomes known; also $\frac{r}{a}$ becomes known by substituting in (6) for V the new velocity, $\therefore$ since r is known a is found; hence a and p' being found the conic section becomes known, hence e is found also; then substituting in (9) for e the value thus found, and for ψ and V their values found as above directed, and $\cos. v$ is found, which gives the position of the perihelion of the new orbit.

The inclination of the new orbit to the orbit described before the impulse, is easily found by spherical trigonometry; their node line is evidently the line r drawn from the centre of force to the point of impulse. (See Prin. sec. iii. prop. 17, cor. 3, and Mec. Anal. Vol. II. p. 66.)

Also, should the particle receive a succession of impulses (acting in given directions) as it moves; then by proceeding in the same manner, by compounding every new velocity with the velocity at the moment of impulse, the curve described becomes known, as stated in cor. 4, prop. 17.

If the impulses act continually, then the integral calculus must be employed according to the methods pursued in estimating the disturbing forces of the planets. (See Mec. Anal. Vol. II. p. 76.)

Art. VI.—*Direct demonstration of the Binomial Theorem in Algebra; by* David Gould.

Notation, $\left.\begin{matrix} a \\ b \\ c \end{matrix}\right\} = \left.\begin{matrix} .a \\ .b \\ .c \end{matrix}\right\} = abc; \left.\begin{matrix} :a \\ :b \\ .c \end{matrix}\right\} = \left.\begin{matrix} :a \\ :b \\ c \end{matrix}\right\} = :a:b.c = c:a:b = c:ab = \frac{c}{ab}$. If b, or $c=0$, then $(b-c) = -c$, or b.

Let $(a+(b-c))^y = a^n + :1.(n-0)a^{n-1}(b-c) + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \end{matrix}\right\} a^{n-2}(b-c)^2 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.(n-2) \end{matrix}\right\} a^{n-3}(b-c)^3 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.(n-2) \\ :4.(n-3) \end{matrix}\right\} a^{n-4}(b-c)^4 +$, &c.

By multiplication,

$(a+(b-c))^y a = a^{n+1} + :1.(n-0)a^{n-0}(b-c) + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \end{matrix}\right\} a^{n-1}(b-c)^2 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.(n-2) \end{matrix}\right\} a^{n-2}(b-c)^3 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.(n-2) \\ :4.(n-3) \end{matrix}\right\} a^{n-3}(b-c)^4 +$, &c.

$(a+(b-c))^y (b-c) = \quad :1.a^{n-0}(b-c) + \left.\begin{matrix} :1.(n-0) \\ :2.2 \end{matrix}\right\} a^{n-1}(b-c)^2 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.3 \end{matrix}\right\} a^{n-2}(b-c)^3 + \left.\begin{matrix} :1.(n-0) \\ :2.(n-1) \\ :3.(n-2) \\ :4.4 \end{matrix}\right\} a^{n-3}(b-c)^4 +$, &c.

$:p.p, = 1;$

$(a+(b+c))^{y+1} = a^{n+1} + :1.(n+1)a^{n-0}(b-c) + \left.\begin{matrix} :1.(n+1) \\ :2.(n-0) \end{matrix}\right\} a^{n-1}(b-c)^2 + \left.\begin{matrix} :1.(n+1) \\ :2.(n-0) \\ :3.(n-1) \end{matrix}\right\} a^{n-2}(b-c)^3 + \left.\begin{matrix} :1.(n+1) \\ :2.(n-0) \\ :3.(n-1) \\ :4.(n-2) \end{matrix}\right\} a^{n-3}(b-c)^4 +$, &c.

and by repeating the process, we get

$(a+(b-c))^{y+2}=a^{n+2}+:1.(n+2)a^{n+1}(b-c)+$, &c. and by continued repetitions we get

$$(a+(b-c))^{y+p}=a^{n+p}+:1.(n+p-0)\,a^{n+p-1}\,(b-c)+\left.\begin{matrix}:1(n+p-0)\\:2(n+p-1)\end{matrix}\right\}a^{n+p-2}(b-c)^2+\left.\begin{matrix}:1.(n+p-0)\\:2.(n+p-1)\\:3.(n+p-2)\end{matrix}\right\}a^{n+p-3}(b-c)^3+,\text{ \&c.}$$

Hence also, *e converso*, by division,

$$(a+(b-c))^{y+p-q}=a^{n+p-q}+(n+p-q)a^{n+p-q-1}\,(b-c)+\left.\begin{matrix}:1.(n+p-q-0)\\:2.(n+p-q-1)\end{matrix}\right\}a^{n+p-q-2}.(b-c)^2+,\text{ \&c.}$$

In this expression, let $n+p-q=1$, or $n+p=q+1$, then the expression for the series becomes $a+(b-c)+0.r=(a+(b-c))^1$.

Hence, $(a+(b-c))^{y+p-q}=(a+(b-c))^1$, whence, $y+p-q=1=n+p-q$, therefore, by subtraction, $y=n$.

Hence, the original equation becomes,

$$(a+(b-c))^n=a^n+n.a^{n-1}(b-c)+\left.\begin{matrix}:1.(n-0)\\:2.(n-1)\end{matrix}\right\}a^{n-2}(b-c)^2+\left.\begin{matrix}:1.(n-0)\\:2.(n-1)\\:3.(n-2)\end{matrix}\right\}a^{n-3}(b-c)^3+\left.\begin{matrix}:1.(n-0)\\:2.(n-1)\\:3.(n-2)\\:4.(n-3)\end{matrix}\right\}a^{n-4}(b-c)^4+,\text{ \&c.}$$

which is the theorem that was to be demonstrated.

ART. VII.—*Short directions for the preparation, preservation, and also the transportation of Mammiferous and Amphibious Animals, Birds, Fishes, &c. Issued by the Senkenberg Institution for Natural History, at Frankfort on the Mayne in Germany; translated under the direction of* WM. C. WOODBRIDGE, *and communicated by him.*

I. *Preparations in Spirits of Wine, Rum, or other Spirits.*

THE animal should first be cleansed from blood, and its abdomen opened by an incision made somewhere near the umbilicus. The cavity of the mouth should be washed, and into it as into the abdominal cavity the spirituous liquor should be poured. In the case of larger animals several incisions should be made through the diaphragm, so that the alcohol may be forced into the cavity of the chest. If the viscera are distended with air, several incisions should be made into them* in order to free them from it. When this has been done, the animal is to be laid in a dish, tub or other reservoir, and the spirits to be poured upon it. In case it remains in them one, two or three days, it should be frequently turned over. As long as the liquid is colored with blood, whether the quantity is small or great, it must be poured off and its place supplied by fresh spirits. This must be done till it is no longer colored. The animal after being thus thoroughly penetrated by the spirit must be kept in an air tight vessel till it is transported; but it must be frequently inspected for the purpose of seeing whether there is not need of renewing the spirits, which will not be necessary unless it loses its odor. Several different animals prepared in this way may be put into one common vessel to remain till the time of transportation.

In the same manner birds, amphibious animals and fishes, may be prepared. It is to be observed however that the matter which is precipitated on the skin of these animals when in spirits should be often wiped off; that the incision into the abdomen should not be large and that the smaller the animal is, the less frequently need the spirits be changed. Mammiferous animals should be carefully cleansed, when the spirits are changed, that the blood may not collect in the hair and produce putrefaction. When birds are preserved in spirit for dissec-

* This mode relates only to the smaller animals. In the case of larger animals all the internal parts should be taken immediately from the chest and abdomen; and from the largest sort the skeleton itself should be taken as will appear from what follows

tion or for preparing a skeleton, care must be taken that the bones be not injured.

Larger animals may be prepared in spirits of wine provided their skins are separated in the manner described below, and their bodies taken out as far as the skull and ancle joints. The process in other respects is the same as with animals of smaller dimensions. The following method is also used for salting the skins of larger animals. Take equal parts of salt and alum and strew them over the skin after it is taken off, and then fold it up. Every part must be freed from adhesive matter and rubbed with the given mixture. After one, two or three days (the length of time to be regulated by the climate or the season of the year,) the process must be repeated until it is sufficiently prepared. To preserve the skin thus prepared, make a brine, which must be so far saturated with salt that an egg will float upon it, enclose the skin in a tight vessel, fill it entirely with the brine, and stop the opening. The preparations which we have described must precede their transportation in spirits. They should be packed in the following manner. At the bottom of the vessel, place a layer of cotton, on this a layer of animals, then another layer of cotton, and so on till the whole space is filled, covering the last with a layer of cotton. The vessel is then to be closed and through an opening, the spirit is to be poured in, till the whole space is filled up. The opening is to be tightly closed, the whole vessel to be well covered with pitch, the hoops fastened, and if desirable for further security, it may be enclosed in cloth, leather or the like.

II. *Preparation in Arsenical Soap.*

(*a*) *Mammiferous Animals.*—The abdomen of the animal should be cut open, the skin ripped down, and the thighs of the hinder feet drawn out until the knee joints can be separated. The tail should then be severed and either drawn out or else have its skin peeled off by cutting it on the under side through its whole length. The skin should then be drawn over the back to the fore feet, the bones of which should be separated at the knee joints and the skinning continued to the head. It should then be detached from the vertebræ of the neck and drawn to the point of the nose, where it should remain attached to the skull. The skull should then be freed from flesh by scraping, and the brains taken out with care. All the parts, the interior and exterior of the skull, together with the skin of the head, should be spread over with diluted arsenical soap, and the skin drawn back again over the head. But first the sockets of the

eyes and the adjoining parts of the skull should be filled with cotton or tow, that the original form may be preserved and the skin dried in the best manner. Here we may remark that the muscles about the ears must be removed, and the skin freed as far as possible from cartilaginous substances and then spread over with arsenical soap. The feet should be skinned as nearly as possible, and the bones cleared of muscles and carefully cleaned. In the case of some animals, the hollow skin should be cut open, separated on all sides, the muscles extracted and all the parts spread over with soap.

Cloven footed animals should have their fetlock joints severed at the hinder part, and the skin taken off as far as the hoof. The whole of the skin and the bones of the feet, when cleaned, should be spread over with the soap, and the abdomen, after it is stuffed, sewed up. All this process however is not *indispensable.* Alum when used for a few days forms a very good preparation, though the skin should afterwards be overlaid with arsenical soap: Skins thus prepared should not be dried in a hot sun, but in the shade, otherwise they will be burned and make bad preparations. When the animal is very fat, the adipose matter which adheres to the skin must be peeled off.

(*b.*) *Birds.*—Birds should be opened in the abdomen, the skin stripped down at the sides until the thighs can be drawn out, the legs severed at the knee joints, and the skin peeled from the calf of the leg, which should be freed from its muscular parts. The skin should then be separated around the tail, the bone of which should be severed from the pelvis, and all the skin disengaged as far as the wings. The bones of the wings should be parted at the shoulder joints, and the breast, the neck and the head laid bare as far as the forehead. Then the skull should be separated from the vertebrae of the neck, cleared of its muscles, tongue, &c. the brains taken out and all the parts supplied with arsenical soap. Afterwards the eye sockets should be filled with cotton and the skin carefully drawn over the skull. The wings should be slit on the inner side, and the muscles about the larger bones taken out, and these parts as well as the whole head lined with arsenical soap. A piece of wood of the length of the body should then be placed with one point in the cavity of the head and the other in the tail, in order to secure the whole skin. The abdomen should be filled with cotton, the feathers placed in order, and a band of paper or packing thread, wound about the whole bird to secure the wings in their proper position. The bird should then be dried. Thus prepared it should be often turned round, which is still

more necessary in the case of mammiferous animals. Although this method secures the preparation from insects, it must nevertheless in warm climates, before the time of transportation approaches, be carefully preserved and packed with aromatic substances.

We may also remark that in the case of some birds the head is larger than the neck, as for instance some kinds of ducks, etc. so that the skin cannot be drawn over it without injury. In this case an incision may be made from the eye to the neck, on whichever side the plumage may have been injured. The skin may then be very easily drawn over the head and the process conducted as before described; after which the incision should be sewed up.

There is also another method of preparation for small birds, viz. the Humming Bird species. To avoid skinning these small birds a wire should be inserted in the vent, in order if possible, to extract the entrails. Then as much arsenical soap should be injected as the cavity will contain, and the opening closed with paper. A similar process should be applied to the head by introducing a wire through the mouth into the cavity of the chest, drawing forth the contents and injecting diluted arsenical soap. The mouth should then be entirely stopped with paper, the bill bound close, the wings bound close to the body, the bird suspended, and, when dried, carefully preserved till the time of transportation as above described.

(*c*) Amphibious animals and fishes are best prepared in spirits of wine in the manner above described, only in the case of larger amphibious animals the body should be sawed in two [as for instance tortoises] or cut in two [as in the case of crocodiles] and then prepared in the same way as the skins of Mammiferous animals. The larger sort of fishes should be skinned. The animal should be laid in the sun till one side is somewhat dry, it should then be slit open on the opposite side from the tail to the cover of the gills, the skin should be peeled off, and the bones of the fins cut with shears leaving the fins on the skin. The whole body should be taken from the skin and then the skin and the cavity of the mouth, and those cavities occasioned by removing the gills together with the sockets of the eyes should be laid over with arsenical soap and all the parts filled with cotton, when the preparation should be dried.

(*d.*) Soft and small crustaceous animals should merely be preserved in spirits of wine. The larger species should be taken out and filled with arsenical soap and cotton.

(*e.*) *Insects.*—The hard shelled insects which have no hair may be thrown into spirits of wine and in this manner killed. Butterflies should be carefully taken between the thumb and finger by the breast under the wings and pinched to death. All other insects must be speedily killed by a needle or if this cannot be accomplished, they should be exposed to a hot sun or fire. The needles must be suited to the size of the insect. Beetles, bugs and locusts should be pierced through the cover of the right wing, just before the centre. All other insects, as butterflies, bees, wasps, flies, &c. should be punctured through the middle of the neck. The head of the needle must be of sufficient length above the insect to be handled with ease. The larger locusts, crickets, &c. should be opened in the abdomen, the viscera taken out and the cavity filled with cotton. The chests, cases or apartments of the larger boxes are according to the best construction about one foot in diameter on the inside, and about the height of the largest needles. They must be made tight and lined at the bottom with cork, or the like, and spread over with arsenical soap before the insects are pinned on. The insects should be very dry and stuck fast to the cork. The larger sorts should also be secured by fastening pins, stuck about irregularly, so that in case the bodies or heads should get loose, they may not roll among the other insects. We should also avoid packing the large and small kinds in the same chest. All the insects should be carefully secured against moths, *wood-borers* and dust. The box should be filled with clean insects, closed and covered on the outside with paper. The smaller cases should be packed for transportation in larger boxes with tow or the like. Very small insects may be killed in a drying glass at the fire and be sent abroad packed in layers between cotton. Hard-shelled insects may also be transported without needles, after they are killed and wrapped in separate papers. Spiders, scorpions, &c. are best transported in spirits of wine.

Insects should be sought after chiefly under stones, mushrooms, and the bark of trees, in rotten wood, mire, dead carcasses, water, &c.

(*f.*) *Crustaceous animals.*—Empty shells are commonly worth little, on account of having lost their color. Those should be sought in which the animal is alive, which should be killed in hot water and permitted to putrefy if it can then be easily drawn from the shell. In case of small snails this is not necessary. Naked snails or slugs, worms, &c. may be transported in spirits of wine. Land crustaceous animals should be sought for especially in shady places, streams and bogs, and the fresh water species chiefly in mud or slime.

(*g.*) *Skeletons.* The skin should be taken off, the flesh, the viscera and the brains removed and all the parts covered with arsenical soap. The feet should be bound close to the body and the skeleton hung up to dry. The same simple course is applicable to all vertebral animals. Animals prepared in spirits of wine should be packed together as mentioned above.

* * * * *

The recipe for making arsenical soap is as follows.

White arsenic,	1 lb.	As much warm water as the mixture requires.
Domestic soap,		
Camphor,	4 ℥	
Unslacked Lime,	2 "	
Potash,	6 "	

N. B. The arsenic should be rubbed with water until it is finely pulverized. The soap should be melted, and the arsenic gradually mingled with the other substances and the whole stirred over a slow fire until it is thoroughly mixed. The vessel which contains it must then be removed to some distance, and the preparation made in the open air. Arsenical soap may also be manufactured out of arsenic and common soap, provided the other ingredients are not to be procured.

Art. VIII.—*On improvements in the Microscope; by* Edward Thomas, late assistant engineer on the Cayuga and Seneca Canal.

The *Achromatic* Microscope is superior to all other kinds where great power is necessary. It was "first constructed [in Europe] at the suggestion and expense of Dr. Goring, by Mr. W. Tully, in the summer of 1824."* This kind has more recently been constructed in this country by my friend Alden Allen, of Boston, (who has executed them with great skill,) and by myself. I have constructed them of the double, treble, quadruple, quintuple, and sextuple forms, the two last of which are the best, when the achromatic lens is designed for the object-glass of a compound microscope.

A quintuple object-glass of mine, which is represented in section by Fig. 1, consists of two concave flint lenses and three convex lenses of plate glass. The lenses of flint glass are represented in the figure by the dark, and the plate lenses by the white spaces, O being

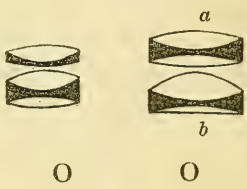
* See "Library of Useful Knowledge," No. 21, page 46.

the place of the object. The surfaces in contact are cemented with Canada balsam, so that the compound lens has only four *reflecting* surfaces, and in consequence the vision is much clearer. The quintuple object-glass has a larger field of distinct vision than any other *achromatic* combination that I have seen.

I have a sextuple object-glass, Fig. 2, shown in section of twice its real size, that consists of two double-concave flint lenses, and four convex lenses of plate glass. Its dimensions and radii are as follows; *a* stands at the first surface, *b* at the last, and O represents the place of the object to be viewed.

			Inch.	
Radius of	1st.	surface,	0.44	plate.
do.	2d.	do.	0.26	
do.	3d.	do.	0.26	flint.
do.	4th.	do.	0.44	
do.	5th.	do.	0.44	plate.
do.	6th.	do.	0.70	
do.	7th.	do.	0.174	plate.
do.	8th.	do.	0.26	
do.	9th.	do.	0.26	flint.
do.	10th.	do.	0.44	
do.	11th.	do.	0.44	plate.
do.	12th.	do.	plane.	

Fig. 1. Fig. 2.



Focus of compound lens, 0.25 of an inch.
Total diameter, . . . 0.25 do.
Clear aperture, . . . 0.20 do.
Specific gravity of flint glass=3.457.

The sextuple object-glass bears a larger aperture, in proportion to its focal distance, than any other that I have used; and the field of distinct vision is greater than it is in any other achromatic combination that I have examined, except the quintuple lens. It is cemented so as to have only four reflecting surfaces. Upon the whole I consider it as the best combination known at present.

The focal distance of the compound lens, Fig. 2, is one fourth of an inch; but when the lens is used as the object-glass of a compound microscope, which magnifies two hundred or three hundred times the diameter, it will show as minute an object, as can be seen with a good *single* lens of mine that has a focal distance of 0.014 of an inch, and which magnifies the diameter five hundred times.

After numerous experiments, I am satisfied, that the principal defect in the achromatic microscope, is not the color of the secondary spectrum, as appears to have been generally supposed, but that it is what may be called the *Secondary Aberration of Figure:* which is occasioned by the spherical aberration increasing in a greater ratio, from the center of the concave, than it does in the convex lenses. When the spherical aberration of the convex lenses, equals the aberration of the concave ones, with a given aperture, I have found from experiment, that if the aperture be diminished, the aberration of the convex will be too *great* for that of the concave; and that if the aperture be enlarged, the aberration of the convex will be too *small* to counteract that of the concave lens or lenses. Were it not for this property, which exists in all the achromatic combinations that I have examined, so many lenses as we are now obliged to use for one object-glass, (in order to have a good one,) would not be necessary. The secondary aberration of figure is not a sensible defect in object-glasses for long achromatic telescopes, though I am induced to believe that it will materially affect very short ones. This aberration might be corrected by making all the surfaces spherical except one, which should be formed by the revolution of an ellipse on its conjugate diameter, when the elliptic surface is convex. But as this is impracticable, there is no way yet known of entirely destroying the secondary aberration. It was, however, much reduced in the sextuple lens above mentioned, by making one of the uncemented surfaces as nearly elliptic as was practicable.

The achromatic microscope might be much improved, if some new arrangement of lenses, with spherical surfaces, could be devised, that would entirely destroy the secondary aberration of figure. Of this defect the sextuple lens has less than any other combination consisting of a smaller number of single lenses; because the radii of the flint lenses are greater, when the focal distance of the compound lens is the same.

I find by experiment that a more minute object can be seen in blue or purple light than in any other, provided the microscope is sufficiently powerful. This probably arises from the *rays of light having a greater magnitude*, at the red, than at the purple or violet extremity of the spectrum.*

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* See "Library of Useful Knowledge," No. 12, p. 32; where the limit of microscopic vision, depending on the magnitude of the rays of light, is treated of by Fraunhofer.

It is not known that purple light has ever been used before for the purpose of increasing the real power of a microscope: indeed it appears to be of no sensible advantage, unless the compound lens will show a more minute object than can be seen with *any single lens.* One of my sextuple object-glasses has a focal distance of 0.07 of an inch; when this is used there is an advantage in the application of purple light, and it is believed that this combination will exhibit a smaller object than any other optical instrument hitherto made.

The superiority of this microscope over those constructed in Europe (as before mentioned,) consists, first, in its having less secondary aberration of figure; second, in having fewer reflecting surfaces; third, in having a shorter focal distance; and fourth, in the application of purple light.

A much simpler combination than the above was suggested, for destroying all the spherical aberration, by J. F. Herschel, Esq. consisting of a double-convex lens with radii as one to six, placed in contact with a meniscus. It was believed that this combination would be nearly free from the errors of color, when purple light was used, and quite free from spherical aberration. But after investigating it both practically and theoretically, I found with regret, that when the thickness of the lenses was such as is necessary to have in an object-glass of high power, that the marginal rays, (although the aberration of figure was much reduced,) had a shorter focus than the central rays. This combination might probably be improved, when its aperture is large, by adding a plano-concave lens of the same kind of which the other two lenses are made, having its concave side towards the parallel rays, and by changing the curves of the meniscus so as to destroy the aberration of figure.

A very simple microscope, mentioned in the American Journal of Science and Arts, Vol. 17, p. 362, was proposed by Dr. Wollaston consisting of two plano-convex lenses with their plane sides next the object, and placed at such a distance from each other as would best correct the color. Though this microscope has advantages, I am satisfied from experiments that the sextuple object-glass is decidedly superior.

Purple light may be obtained by causing the sun's rays to be refracted through the prism, which will sufficiently separate the colors when it is placed ten or twelve feet from the microscope. It is probable that purple light would be preferable to any other, if it could be obtained sufficiently strong; but from experiment it appears that blue light answers the purpose as well, on account of its greater intensity.

In viewing most objects with blue or purple light, it is necessary to cause the light to pass through a surface of ground glass, which should be placed one or two tenths of an inch further from the object-glass of the microscope than the object viewed.

Cayuga County, New York, June 16, 1830.

Art. IX.—*Notice of the Aranea aculeata, the Phalœna antiqua and some species of the Papilio; by* Miss D. L. Dix, of Boston.

Aranea aculeata.

I last summer discovered an insect in Rhode Island which I have seen elsewhere, and of which I have read no description. It is of a species belonging to the large family Aranea, bearing a strong resemblance to that designated by Fabricius as the Aranea aculeata; I think it belongs to the genus Epeira distinguished by having its eyes arranged in this manner  . It spins and weaves a geometrical web, remarkably delicate and prismatic. The body of this insect forms a *solid equilateral triangle;* one plane of which forms the back, curiously marked with unequal chesnut brown and yellow spots; the sides of the angle measure one third of an inch; the head is connected to one apex of this angular plane,—the others, each terminate in a sharp *thorn;*—on the apex of the abdomen are situated the organs from which the web is drawn. The whole body is encased in a *smooth hard shell,*—and so singular is the whole appearance of the insect that it was some time before I could even decide whether it belonged to the class of spiders;—it is singularly timid and inoffensive;—if disturbed in its web, it quickly falls to the ground, where it remains motionless till the danger has passed. I confined eight in a glass vessel;—they seemed terrified when coming in contact with each other and held themselves as widely divided as the circumscribed limits of their prison would permit. While in confinement they spun with great industry, apparently with the purpose of concealing themselves, for now their webs were cast closely and irregularly together, in every possible direction, after the manner of the *weavers.* This spider is found in the woods, upon low shrubs. The last summer they were much less numerous than the preceding season.

PHALÆNA ANTIQUA,
WHITE SPOT TUSSOCK MOTH,
or
VAPOURER,
LEPIDOPTERA.

Generic Character.—Antennæ taper from the base: no trunk: wings depressed: back hairy.

Specific Character.—Antennæ feathered, first wings cloudy, waved and spotted with brown, and a white spot on the posterior angle.

The female Vapourer Moth, at first sight perfectly resembles an apterous insect; but on inspection, very small wings are seen on the extremity of the thorax, and the antennæ determine it to be a Phalæna. It creeps in a sluggish manner, and deposits many eggs.

The Phalæna antiqua, of which I send you a drawing, was the last season unusually destructive to the thorn hedges;—appearing very early in summer, and not disappearing till late in November. The period of individual life I could not determine.

But the larva, of what I conjecture to be one of the Sphinges, has most perplexed my efforts at investigation. My love of natural history and constant search after objects of curiosity and interest, had enlisted in my service the gardener, and his subordinates, who never failed of bringing forthwith to my hand, whatever they found, animate or inanimate, that was likely to become a subject of study. A boy brought me the small branch of an apple-tree, and I was proceeding to examine the insects which were feeding upon its leaves, when to my amazement, something which had seemed a part of the stem, began to move, and presently passed with great rapidity to the extremity of the branch. When at rest the resemblance of the upper surface was so exact with the young bark of the branch on which it was fixed, that I am persuaded its presence might have escaped the most accurate investigation—and this deception was the more complete from the unusual shape of the caterpillar, not less than the color. I can liken it to nothing save the *external third* of a *hollow cylinder*—and I fear this awkward simile will hardly be intelligible. The under surface of the body is brilliant *orange*, spotted with *vivid black;*—the superior surface, which I before noticed as assimilating in appearance to the young bark, was *pale sea green*, marked with *ash*, *blended* into *white*. When in motion the whole appearance of the reptile is changed;—the colors brighten;

the extremities are extended;—the body lengthens, (and now measures *more* than *two inches*, while the breadth is *two thirds* of an *inch;*) a transverse opening is disclosed on the back, two thirds of an inch from the head,—and of a most rich velvet black color. The reptile was sluggish during the day, and motionless, except when much disturbed; but on the approach of night,—and in the night, there seemed perpetual action, except a strong light was introduced. When much irritated, it protruded two green horns or feelers, moving them rapidly, and emitting an unpleasant odor.—But that which most strikingly distinguished this caterpillar, was a cloak-like appendage, covering the whole body including the head, and fringed semicircularly around the stigmatæ, the hairs diverging in a most curious manner. This "Calymphorus" of reptiles, I have never seen either described, or living except the specimen which has furnished this subject; nor do I find in any work on Entomology any thing at all resembling it. Through the carelessness of a domestic, I lost this caterpillar after having diligently noticed its habits for three days.—I am pretty well satisfied that it is carnivorous.

Papilio or Butterfly.

I have reared from the egg from forty to fifty individuals of the Papilio, described by Say as the Danaus Plexippus, (Linmus Feruginea Plexippe,) which in its Larva state feeds on several varieties of the Asclepias. I have noticed with accuracy its many changes from its first escape from the egg state, to its ultimate perfection as a winged insect; together with the intervals between each change, and I can imagine nothing more interesting to the student or even the casual observer than the metamorphoses from the Caterpillar to the Pupa, and the Chrysalis to the brilliant and perfect insect. The larvæ of the Papilio hirundo are also very noticeable in some of their habits, and though in the Pupa state, less interesting than the Papilio Danaus, not less beautiful in its perfection as a winged inhabitant of the air.

Art. X.—*List of the plants of Chile, by* Dr. C. Bertero; *translated from the "Mercurio Chileno," and forwarded for this Journal; by* W. S. W. Ruschenberger, M. D. U. S. Navy.

Preliminary Remarks abridged from an address to the Editors of the Chilian Mercury.

Gentlemen.—It is well known that Chile unites, in a smaller extent, a greater number of circumstances favorable to the people who

inhabit it, and offers more resources for the establishment of mercantile relations with the principal commercial nations of Europe, than any other country of South America. The coast of the Pacific Ocean, is much indented by ports, bays, and the mouths of navigable rivers which give to the country a facility in diffusing the products of its soil and industry, and of insuring favorable returns without the necessity of recurring to the difficult means to which neighboring people are obliged to resort. The chain of the Andes is a source of incalculable benefit to this region. The difficulties of its passages protect Chile from foreign invasion; it offers also a barrier to the wind, and by it, all meteoric phenomena are modified advantageously for the inhabitants. The salubrity of the air cannot be greater in any similar latitude. The waters, which, in every direction, irrigate the plains, are precipitated from the summit of the Cordilleras, where the snows have for ages fixed their dwelling. The whole of this immense extent is varied with hills and mountains of every size, which at the same time augment the geographical superficies and give variety to the climate. In a word, Chile may very properly be styled the American Italy.

Its mineral wealth has, ever since the discovery of the country, occupied the attention of speculators, and is a source of great national benefit. I leave to those who profess this very interesting branch of natural history, the labor of acquiring by their investigations, a correct knowledge of this fountain of riches, and of devising means to explore them with more security and less expense, conditions particularly required to avoid the fatal accidents (and failures?) which have been unfortunately but too much multiplied.

The vegetation in this region, flourishes in vigor and affords many very important resources. The precious woods, the esculent plants, and the immense variety of fruits present great advantages to the arts and commerce. Finally, animals, and particularly those most useful to man, have found in Chile a new country and contribute with those proper to it, to augment its resources.

Among the means used by civilized nations, to increase their commerce and their felicity, the principal is, without doubt, agriculture. History and the experience of the present time confirm this principle. Every agricultural community renders itself independent of foreign industry, and secures equality among its own people, and reciprocity with foreign nations. In a word, a nation is morally free if its people are mainly agriculturists. This branch of national industry

daily becoming more important, must submit itself to the rules of sound philosophy and experience. A knowledge of our own vegetable productions is in many respects valuable. Agriculture, commerce, medicine, and the arts, receive a large contribution, from the science of botany, which offers at the same time, real utility and an inexhaustible source of pleasure.

I formerly promised you my remarks on the botany of this country over which I have been travelling for a year. I here offer the result of my observations, made in a small space it is true, and they may therefore be supposed to have only a local interest; but knowledge is always valuable and is not restricted in its applications. Two objects have particularly engaged my attention. First—The natural productions of the soil. Second—The means of investigation and the products which may be obtained by different kinds of culture. My avocations oblige me to limit myself for the present to the first point, reserving the second for another opportunity.

Till lately the territory of Chile has not been explored, with a view to its botany. Besides some vegetables common to neighboring nations, this country embraces a great number of new and interesting objects. The labors of Feuillée, Frezier, and above all those of Molina, although imperfect with respect to the epoch in which they were undertaken, alone, give an idea of the richness of this soil. The loss of the ship Pedro de Alcantara, which occured in 1786 deprived Europe of the beautiful collection of the celebrated botanists Ruiz, Pavon and Dombey. The *science* is reduced to a very imperfect and limited knowledge obtained through the means of travellers that accidentaly visit the coast and seldom the interior. The learned botanists Cavanilles, Lagasca, Hooker, Lindley, De Candolle, Schlechtendal and some others have published the description of some new species which they have received. Miers, in his voyage to Chile has published the names of those plants which he himself collected. If it were possible to unite in a body all this information, correcting and augmenting it by new investigations, there is no doubt but it would be of great service to the science and to the inhabitants. But an undertaking of the kind is not within the power of one individual. Government alone can favor its execution by supplying every thing necessary to him, who is capable of undertaking so painful a task.

Visiting the space comprehended between Valparaiso, Rancagua and San Fernando, I have observed that the vegetation bears considerable resemblance to that of the south of Europe and particularly to

that of Italy, as many plants are common to both regions, and European vegetables prosper well here. With this fact in view we should essay the acclimation of a great number of species whose utility is known and in this way increase the comforts of the inhabitants, and the products of a soil highly favored by nature. It is not strange that Chile produces species proper to Peru and the river La Plata since the proximity of these countries affords a natural explanation. But what surprises me is to find a resemblance with the Cape of Good Hope and New Holland. I think that in proportion as we approach the country of Arauco these similitudes will be more apparent.

Although the quantity of matter I have collected may be considerable it is too limited for scientific classification. Immense vacuities would remain which would leave the work very imperfect without the hoped for advantages resulting. Therefore to give the public a slight sketch of the vegetable productions which I have seen and examined, I made use of alphabetic arrangement which has no other advantage than facilitating investigation. I have thought necessary to add the common names most frequently used. They will serve to inform the inhabitant of the true nomenclature, and lead him to seek in books the history of the plants which engage his attention, and at the same time will be a great aid to strangers in abbreviating the labor of indagation. I shall not overlook exotic plants which have been introduced and are cultivated in gardens and other places for amusement or utility. In this way we shall not fail to see those which should be preferred and which may hereafter be profitable. Medicinal properties are invaluable and particularly in the country where generally pharmaceutic preparations and persons skilled in their administration are rare. A materia medica of the vegetables of the country would be a work of the greatest interest.

Very sincerely your servant, &c.

CHARLES BERTERO.

List of the plants of Chile; by Dr. Bertero.

Acacia Cavenia. Bertero. A very common tree in the plains and the declivity of the mountains; its height varies from three to ten varas.* I have observed it highest in elevated places. It is commonly called *espino.* Molina, places it in the genus *Mimosa*, and

* A vara is equal to thirty inches and is a Spanish yard.—T.

Steudel and De Candolle have followed him and have only cited it from the description of that author. Its flowers known by the name of *Aroma*, exhale a very sweet odor like those of the *Acacia Farnesiana*. The seeds enclosed in an almost cylindric pod have a very bad taste when chewed and impart to the saliva, a very nauseous and insupportable smell. It is said that burnt paper obviates this. The wood is solid hard and weighty; of a bright yellow; the heart red. Its wood makes good charcoal and is commonly used for domestic purposes; but as its consumption is great and as the tree is becoming scarce in the neighborhood of the towns, and being of slow growth, it would be well to replace it with shoots of poplars or of some other trees easily obtained. It is also employed in palisades and its branches being covered with thorns it makes an excellent hedge. With its trunk are formed beams for building and forks (*horcones*) for vineyards. It does not rot under ground but exposed to the air is attacked by insects. Turners use it in different works and it serves equally well for cart-wheels and door-ways. It yields a gum which might be substituted for the Arabic were it more abundant.

Acacia strombulifera. Willdenow. Known by the name *Retorton*. This small tree is originally from Peru and is found cultivated in gardens. To the pods is attributed the virtue of curing tooth-ache and diseases of the gums.

Acaena pinnatifida. Ruiz and Pavon. A slightly astringent plant which grows in stony pasture grounds; its fruit is called *amor seco* or *cadillo*.

Adenostemum nitidum. Persoon. Tree from ten to fifteen varas high. It is found in the woods in the neighborhood of Leona and is known by the name of *ulmo* (elm). It does not differ perhaps from the *Queule* which grows in the province of Conception. Its appearance and foliage are elegant; its fruit resembles a small orange. It should be cultivated as an ornamental tree.

Adesmia. Genus established by De Candolle. Many of its species have been described by authors under the name of *Hedysarum* and *Æschynomene*. The *Palhuen* which I have named *A. arborea*, a pretty shrub which is found in the stony and arid situations about hills approaches the *Zuccagnia punctata*. Cavanilles. Its foliage, the number and color of its flowers, and above all its pods, clothed with very long and different colored hairs, make it interesting in English gardens. The other species are all herbaceous, as the *A. longiseta*, *muricata*, *papposa*, *pendula*, and *Smithiæ*, De Candolle,

and the *A. vesicaria* and *viscida*, Bertero. All these plants grow in stony places, about hills and along rivers. The name *Alberjilla*, which is common to many other leguminosæ, is given indefinitely to it. All these should be cultivated on account of the variety of the color of the flowers.

Adiantum. All the species of this genus are kown by the name of *Culantrillo.* The *A. scabrum*, Kaulf. and its variety of velvet leaves which might constitute a different species, are found in pasturages and between the rocks of the mountains. The *A. tenerum*, Sw. and the *A. Chilense*, Kaulf. are exceeding common in stony and humid situations. The *A. sulphureum*, Kaulf. is found at the foot of trees and in shady woods. This last species is very beautiful on account of the sulphur-yellow of the under part of its leaves which makes a fine contrast with the dark green of the plant and brilliant black of the stem. The *Culantrillo* is often employed by the country people as a tonic, vermifuge and emmenagogue.

Agaricus. Among the species of this genus found in the country, and which are more common in winter, and particularly after rain, the only one distinguished particularly is the *A. campestris*, Bull., to which the name of *Cayampa* has been given and is the only one eaten. All the others are confounded with the common names, *Hongo*, *Cayampa*, *Cayampita* and *Cayampa del Diablo.* In the fourth Number of el Mercurio Chileno, the names of some cryptogamæ are published, which I communicated, and among which is the *Agaricus.* I have species of the same genus which I have since found and which I have been able to determine. *A. albidus*, Persoon, *A. atrofuligineus*, *A. conglutinatus*, *A. curvipes*, *A. omphalomorphus*, *A. ruderum*, *A. versatilis*, Bertero and *A. violaceus*, Linn.

Aira Caryophyllea, Linn. Grass common in dry pastures. Another species is found which much resembles the *A. pulchella*, Willdenow; although I think it different. These two plants have been probably introduced. The generic name of *Pasto* is given them, and they are used only for fodder.

Alchemilla Aphanes. Leers. A small plant which grows in elevated fields and on rocks. Ruiz and Pavon distinguish it with the name of *A. Tripartita*, and it does not appear to differ much from the European species save in being more downy and more profound in the figure (recortes) of the leaves.

Alium sativum, (ajo, garlic) and *A. Cepa*, Linn. (cebolla, onion) cultivated plants whose use is well known.

Aloe. A fatty plant cultivated in gardens and vulgarly called *Savila.* Its parenchyma is employed to soften corns and its juice is purgative.

Alstroëmeria. I have met with two species of this genus. The first is the *A. Simsii*, Sprengel; called *clavelillo* in the country where it is very common and *Peregrina* in gardens, where it is cultivated for the elegance of its flowers. The color of its petals varies much, as well as the form of its leaves which are sometimes naked and sometimes velvety. It is probable there are two distinct species. The other grows in stony places, along torrents and particularly near San Fernando. It has some analogy to the *A. revoluta*, Ruiz and Pavon. The roots of these plants are garnished with oblong and diaphanous tubercles and yield an abundant fecula similar to that obtained from the *A. Ligtu*, Linn. in the province of Conception and that which is called *Ligtu* or *Chuño;* it would be useful to attempt the cultivation of these.

Althea rosea. Linn. A garden plant known by the name of *Malva Jaspeada;* it comes from Europe. The variety and duration of its great flowers give place for the plants to propagate. The infusion of its flowers is administered in catarrhal affections and the decoction of its root as a sudorific.

Amaranthus. Some species are cultivated in gardens, as the *A. tricolor*, Linn. (*ala de loro*) the *A. hypochondriacus*, Linn. *A. hybridus*, Linn. (*penacho*); others are wild though probably introduced. I have noted the *A. sylvestris*, Desf. the *A. adscendens*, Lois, *A. flavus*, Linn. and *A. prostratus*, Balbis. This last is found every where and is distinguished by its flowers with two stamina and its sharp root. It is met with sometimes in shady places with almost straight shoots. All these plants are called *bledo.* Its leaves when tender are eaten as spinage.

Amaryllis. The species common to the country are commonly named *Amencay.* I have found the *A. Chilensis*, Herit.; in sandy and barren situations in the neighborhood of rivers. The *A. Ignea*, which Lindley now refers to the genus *Phycella*, is very common in shady and humid places, about hills. The *A. formosissima*, Linn. *A. Reginæ*, Linn. (flor del irio,) and *A. ornata*, Linn. (nardo) are cultivated in gardens. I would observe here that the lovers of floriculture, who make great sacrifices to procure foreign plants with a view of augmenting their collections should collect all the bulbous plants of the country known under the name of *flores de*

papas. By this easy plan they would increase their pleasure and would have the satisfaction of introducing into commerce very interesting and even new plants which would be sought after by gardeners. A complete collection of the bulbous plants of Chile would be prized in Europe.

(To be continued.)

ART. XI.—*Original and select Observations on the detection of Adulterations; by* EDWIN D. FAUST, M. D. Columbia College. S. C.

Traité des moyens reconnaitre les falsifications des drogues simples et composées, et d'en constater le dégré de pureté. Par A. Bussy, professeur de Chimie á l'Ecole de Pharmacie de Paris, Professeur á l'Ecole de Commerce, Membre de l'Académie royale de Médecine, et de plusieurs Sociétés savantes; et A. F. Boutron-Charlard, Pharmacien, Membre de l'Académie royale de Médecine, de la Société de Pharmacie de Paris, etc. Paris, 1829.

No subject is more important and interesting to physicians and apothecaries, and, indeed, to many artists, than that which has been so judiciously treated in the above work. The want of a good treatise on the mode of detecting the adulterations of our medicines, has been felt by every practising physician in this country; and the profession could not be more usefully served, than by the compilation of a suitable treatise, or the translation of that to which we here call the attention of our readers.

Believing that such information would be very acceptable to many readers of this Journal, we have attempted to embody in the subsequent pages, as much information on some of the most important points, as our limits would allow; taking for our guide the work in question; from which we must be considered as having obtained the facts, though many of them will be recognized as common to various authors.

Hydrocyanic Acid; Prussic Acid.—In this country it is scarcely possible to obtain two specimens of the same strength; and this uncertainty has rendered practitioners very timid in the employment of a very useful medicine. We have taken, at one dose, ten drops of a preparation which a friend had used for some time, and with apparent good effect, in the dose of one drop. We are at present engaged in an attempt to determine the best mode of preparing and ad-

ministering this acid, but have, as yet, only satisfied ourselves, that the alcoholic solution is, for internal use, the best form.* In using the acid which has been prepared by passing sulphuretted hydrogen gas through a solution of cyanuret of mercury, care must be taken to ascertain that the whole of the mercury has been precipitated; as we have known patients to be salivated by an acid containing a very small proportion of mercury. The best mode of detecting the impurity consists in putting a few drops of the liquid upon a plate of gold, and then placing a clean piece of zinc in contact with both gold and acid; if mercury be present, the gold will be whitened. Tin must not be used in place of zinc. The comparative strength of any two specimens may be ascertained by distilling equal quantities of each, from retorts into receivers containing a solution of nitrate of silver; by which a white cyanuret of silver will be precipitated, every 1681.66 grains of which indicate 342.495 grains of pure acid. We would suggest the propriety of adding some bits of iron to the acid, an hour before the above process, in order to neutralize any hydrochloric acid which might be present. If any portion of the precipitate be insoluble in nitric acid, it may be considered as chloride of silver.

Alcohol.—The alcohol of commerce is contaminated by coloring matter and water, from which it may be purified by exposure to substances having a strong affinity for water, and subsequent distillation. When distilled from acetate of potash or chloride of calcium, it contains a small quantity of ether; which, however, does not impair its medicinal properties. Neither is it injured by the minute quantity of oil which it often contains, and which varies with the vegetables from which the spirit has been obtained. The quantity of water contained in the alcohol of commerce, or in any specimen of dilute alcohol, may be easily determined with sufficient accuracy for pharmaceutical purposes. Put into a bottle 100 drachm measures of the fluid, and add small lumps of dry carbonate of potash (pearlash) until they cease to dissolve; after some hours pour off the alcohol, and measure it accurately. Its volume, subtracted from the original measure, will indicate the quantity of water. The specific gravity of alcohol which has been freed from solid matter by distillation, is a still more

* We have exposed a dilute solution of this acid in concentrated alcohol to the direct beams of the sun, for many hours, without any change of color or other evidence of decomposition.

accurate index of its dilution; but few persons have the necessary apparatus, and the preceding process is at once easier and more than sufficiently accurate.

Ammonia.—Among the impurities sometimes found in the liquid ammonia of commerce, is a portion of oil derived from the animal matter used in the early stages of its preparation. If ammonia be very cautiously mixed with a great excess of concentrated sulphuric acid, the presence of oil will, after some time, be indicated by the evolution of charcoal. The presence of hydrochloric acid may be discovered by saturating a portion of the alkali with pure nitric acid, and then adding a solution of nitrate of silver, which will give a precipitate of chloride of silver, if any of the suspected acid be present. Sulphuric acid is detected in ammonia, by saturating the alkali with pure nitric acid, and then adding any solution of barytes; if a precipitate occur, the alkali contains a sulphate. It is necessary to add the nitric acid in the first place, because a precipitate would otherwise occur from the presence of a little carbonate of ammonia, which the liquid of commerce almost always contains. The strength of the volatile alkali is greater in proportion to its lightness and the intensity of its odor.

Arrow-Root.—This substance is sometimes largely adulterated with starch, and the fecula of potatoes. The color however, of arrow-root, is less white than that of the two latter substances, its grains are much finer, and when examined with a magnifying glass appear pearly and very brilliant. It also contains small lumps, which very easily crumble between the fingers. Finally, the jelly made from arrow-root and water is inodorous; while the other substances have a very distinct smell. Such are the distinctive characters given by our authors, and it is important to observe them.

Proto-chloride of Mercury, Calomel.—This substance, when pure, is entirely volatilized by heat; any fixed residue being an impurity. As, however, it is liable to contain a little corrosive sublimate, which is also volatile, and which would be a very dangerous contamination, it is proper to state the process by which that poison may be detected. Digest a portion of calomel with four times its weight of rectified alcohol, at a moderate heat; filter the alcohol, then dilute it with an equal weight of water, and add lime-water. If the corrosive sublimate be present, a reddish precipitate* will be formed.

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* Rather a yellowish red. It is difficult to name the color.

To remove every portion of corrosive sublimate from calomel, the latter must be repeatedly washed with large quantities of water, or with a weak solution of hydrochlorate of ammonia.

Chromate of Lead.—This salt, although not used in medicine, is so valuable in the arts, and the temptation to adulterate it is so strong, that our authors have very judiciously given it a place in their work. Its fine yellow color is so brilliant, that it admits of considerable additions of foreign matter, without any very notable depreciation of color. The presence of the carbonates of lime and lead is easily detected by the effervescence excited by the action of acids. To determine which of these carbonates is present, we would recommend that the hydrochloric solution should be evaporated to dryness, the dry mass washed with water, the solution saturated with ammonia, filtered and then tested with oxalate of ammonia, which will discover lime by a white precipitate. If the paint be mixed with starch, it will afford the usual appearances of vegetable decomposition, when exposed to a low red heat. The sulphate of lime has been employed for the same fraudulent purposes, and with greater success, than the carbonates already mentioned. We shall sometimes succeed in seeing the white particles of this salt, in the yellow mass. When this cannot be accomplished, mix the chromate with one fourth its weight of charcoal, and expose the mixture to a red heat, in a crucible. This will reduce any existing sulphate to a sulphuret, which being thrown into dilute hydrochloric acid, will give the odor of sulphuretted hydrogen. The solution is now to be filtered, saturated with ammonia, filtered again, and tested with oxalate of ammonia, which will, if lime be present, give the usual precipitate. We would observe, that if this precipitate be very scanty, it probably proceeds from the paper filters, and not from any intentional fraud.

Copaiva.—It is very difficult to obtain this article in a state sufficiently pure for medical purposes. The chief adulteration is castor oil; the presence of which may be detected by several processes. M. Henry advises that a drachm of copaiva be boiled with a pint of water, until almost the whole of the water has evaporated. If the copaiva be pure, this process renders it dry and brittle; while, if adulterated with castor oil, it preserves a degree of softness proportionate to the degree of impurity.

M. Blondeau has ascertained that a mixture of four parts of copaiva with one of carbonate (sous-carbonate) of magnesia possesses after standing some hours, the transparency and consistency of a concen-

trated mucilage; while, if castor oil be present, the mixture is opaque.

Our authors prefer, however, the process of M. Planche. Mix thoroughly one measure of ammonia, sp. gr. .915 with three measures of copaiva. If the copaiva be pure, the mixture will be transparent; while castor oil will produce an opacity proportionate to its quantity. The test succeeds best between the temperatures of 50° and 60° Fahrenheit.

M. Ader gives the following process for obtaining the volatile oil of copaiva, without distillation. Agitate strongly in a matrass, 100 parts of copaiva, and the same quantity of rectified alcohol; then add 37½ parts of a solution of caustic soda sp. gr. 1.373, and after repeated agitation add 150 parts of water. In a few hours the volatile oil is found on the surface of the solution. If the copaiva be pure, and the process carefully conducted, about 44 per cent. of oil will be obtained.

It is well known, that when pure copaiva is mixed with one seventeenth of its weight of very pure magnesia, it becomes, on standing, so solid that it may be formed into pills, possessing the medicinal virtues of the liquid, without the unpleasant taste and odor, or the irritating characters of the latter. Of several specimens which we have obtained, but one has been pure enough for this purpose.

Iodide of Potassium.—This substance, when in solution, is a hydriodate of potash; and is commonly sold under that name. When adulterated with substances having less action on the animal frame, it will, of course, require a larger dose to produce a given effect, than when pure. The consequence has been, that physicians who have with safety employed large doses of an impure salt, and subsequently used a pure preparation, have produced violent and unexpected effects, by giving the doses which they had been accustomed to employ. The chloride of potassium, and common salt have been discovered by M. Robiquet, as impurities in this iodide; and the resemblance is so strong, that the fraud cannot be detected by the eye. M. Robiquet has proposed the following processes for ascertaining the existence and extent of the impurity. Dissolve equal quantities of pure iodide and of that to be tested, in similar portions of water, and introduce the solutions into retorts connected with receivers. Add to each an excess of nitric acid, and boil to dryness. The iodine will be liberated, and must be dried and weighed. Both specimens should yield the same quantity. We do not perceive the necessity of making this comparison, since it is known that 165 grains

of pure iodide contain 125 grains of iodine. We are now directed to redissolve the solid matter contained in the two retorts, and to test them both with nitrate of silver. The solution derived from the pure iodide will, it is said, give no precipitate; while that obtained from an iodide containing a chloride, will let fall a copious precipitate of chloride of silver. This last does not appear probable to us, because the nitric acid must have previously expelled the chlorine; and this the more completely in proportion to its excess in quantity.*

Another process of M. Robiquet consists in dissolving in separate portions of water, equal quantities of pure iodide of potassium, and of the preparation to be examined, and precipitating both by nitrate of silver. The liquid being then decanted, and ammonia added, any chloride of silver present will be dissolved, and the weights of the two precipitates will differ; while, if both specimens be pure, the ammonia will dissolve nothing, and the weights of both precipitates will be equal. It is quite unnecessary as Bussy and Boutron-Charlard have shown, to make two solutions; as 265 grains of iodide of potassium will give with nitrate of silver, a precipitate insoluble in ammonia, and weighing 235 grains. Any deviation from this weight indicates impurity.

Lemon Juice.—The mineral acids sometimes added to this substance render it unfit for the preparation of lemonade, by giving it irritating properties very injurious in those inflammations of the digestive organs in which lemonade is so frequently and properly used. The means for detecting these will be stated when we treat of vinegar. A more frequent impurity is verjuice and tartaric acid. To detect these, add to a portion of juice, a tolerably concentrated solution of acetate of potash in moderate quantity. If the suspected impurity exist, small crystals will be formed immediately or gradually which will be found to possess the properties of cream of tartar. If the juice be pure, no crystals will appear; as the citrate of potash is very soluble.

Morphine.—This valuable substance generally contains a portion of narcotine, not intentionally added, but resulting from the processes

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* Thénard says, " Quant à l'acide nitrique, il produit sur tous les hydro-chlorates le même effet que l'acide hydro-chlorique produit sur les nitrates, c'est-à-dire que, mêlé en excès avec ces sels, il les décompose à l'aide d'une légère chaleur, et qu'il en résulte d'une part un nitrate, et de l'autre de l'acide nitreux et du chlore." Traité de Chimie, Paris, 1827; tom. 3, p. 331.

by which the former alkali is usually prepared, and capable of interfering with the simplicity of its action on the human system. The same process serves both to detect the impurity and to remove it. It consists in treating the morphine with repeated portions of rectified sulphuric ether; by which the whole of the narcotine will be dissolved, while the morphine is very slightly acted upon. By evaporating the ether, the narcotine will be obtained separately. Morphine should be entirely soluble in alcohol.

Oil of Sweet Almonds.—When this oil is obtained from almonds which have been placed in boiling water, it is less mild, and is more disposed to become rancid than when the almonds have not been exposed to heat. A very sweet oil is also obtained by pressure, from bitter almonds; but if these be previously exposed to hot water, the oil will have the odor of hydrocyanic acid, and will not supply the place of good oil. It is sometimes adulterated with oil of poppy seeds, and the impurity may be ascertained by agitating the oil in a vial; when, if it be so adulterated, bubbles of air will attach themselves to the sides of the vial; a circumstance which does not occur when the oil is pure. The latter oil gives also to that of almonds, a particular taste, which may be recognised as different from that of the pure oil.

Oil of Olives.—This oil is sometimes mixed with the oil of poppy seeds; which addition renders it less fit to combine with alkalis, or to form plasters; and the soaps and plasters made with it, have the inconvenience of adhering to the fingers, on account of their softness. The taste and odor of the oil of poppy seeds are different from those of olives, and the consistence of the former is greatest; so that when a specimen of sophisticated olive oil is shaken, the bubbles disappear much less rapidly than when the liquid is pure. The pure olive oil, when put into a glass tube, and exposed to melting ice, congeals promptly; while, if sophisticated, the effect is produced less speedily, in proportion to the degree of impurity. M. Poultet employs the nitric solution of mercury for the purpose in question. This solution consists of six parts of mercury, and seven and a half parts of nitric acid sp. gr. 1.373. Mix in a tube, one part of the mercurial solution, and twelve parts of the oil, and shake the mixture at intervals. The mixture will become thick; and if the oil be pure, will, by the next day, be solid. If the oil of poppy seeds be present, the consistence will be less, in proportion to the quantity of that substance. This test, though not indicating the degree of adulteration with very great

accuracy, is sufficient for most purposes. We must refer to the work of Bussy and Boutron-Charlard, for another and more accurate process, which, owing to the figure required for its illustration, cannot be conveniently introduced into the present paper.

Oil of Ricinus Communis.—Castor oil, when pure and fresh, acts very mildly upon the system; but when rancid, it is very irritating, and is unfit for use as a medicine. It should be very nearly colorless, and free from any acrid taste. When mixed with other fixed oils, the impurity may be detected by agitating the oil with eight times its volume of alcohol sp. gr. .827 or .817. Any portion which is not dissolved by the alcohol, may be considered as a different oil. Particular attention is paid to the specific gravity of the alcohol, since a very moderate variation from the weight above stated, will produce a considerable difference in the solvent power of the spirit. Very pure specimens of castor oil sometimes assume the form of a soft solid, by a slight diminution of temperature; and this has led to an erroneous opinion that such preparations were adulterated. When, however, an oil appears pure in other respects, this property is not objectionable.

Volatile Oils.—These substances generally bearing a high price, are very liable to be mixed with various liquids of less value. The fixed oils which are frequently used for this purpose, communicate a greater consistency than the volatile oils themselves possess. The fraud is also discovered by attempting to dissolve them in eight times their volume of alcohol sp. gr. .817; the volatile oil being dissolved, while the other is separated. This, however, does not discover the presence of castor oil; for the detection of which, we may employ a test applicable to the other fixed oils also and which consists in dropping a little of the oil on a piece of unsized paper, which is then to be moderately heated. If the liquid be pure, it evaporates completely; while if any fixed oil be present, it gives the paper a greasy stain. The increased tenacity conferred by the castor oil, must also be kept in view.

Alcohol is sometimes added to the volatile oils, and does not increase their consistency, nor does it affect their color, unless its quantity be considerable.* This substance may be detected by agi-

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* Would not a mixture of proper proportions of volatile oil, castor oil, and alcohol, closely resemble the volatile oil? The proper test in this case would be the unsized paper.

tating the oil in contact with water; by which means if alcohol be present, the volume of the water will be increased, while that of the oil is diminished. If the experiment be performed in a graduated vessel, the quantity of alcohol may be ascertained; allowance being made for the very small quantity of oil dissolved by the water, and that adhering to the sides of the vessel.

To discover the presence of very small portions of alcohol, M. Béral proposes the immersion of a small piece of potassium to the oil. If alcohol be present, the metal assumes a globular form, becomes brilliant like mercury, is oxidized, and disappears in a minute or two, with a slight sound. These phenomena occur with less activity in proportion as the quantity of alcohol is less. This test has been found effectual in all the volatile oils tried by M. Béral, except that of turpentine.*

The adulteration of one volatile oil with another, makes the difficulty of detection very great; and we are here advised to compare the suspected fluid with a specimen of known purity. The concluding remark of our authors on this subject, we prefer stating in their own words, as the fact stated is new to us. "Néanmoins on a remarqué qu' en imbibant de ces sortes d'huiles mélangées un ligne ou un papier, l'huile la plus fixe commence par se dissiper, et que celle dont l'odeur est la plus pénétrante ne s'évapore qu' en dernier lieu, et peut ainsi être distinguée."

Peroxide of Manganese.—As the purity of the mineral oxide varies, not only in regard to the quantity of oxygen, but from the presence of foreign substances, it is very important for the artist to possess the means of determining the quality of any specimen which may be offered him. The process which we shall detail, is that of Gay-Lussac; its object being to ascertain the quantity of chlorine which the oxide is capable of affording. Take of the oxide to be examined 61.451 + grains; put it into a small matrass about two and a half inches in diameter, and add about 3.861 cubic inches of strong hydrochloric acid free from sulphurous acid. Immediately insert a close stopper from which proceeds a bent tube of about one tenth of an inch internal diameter, its longest branch being about twenty three inches in length. This branch is introduced into a long tube nearly

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* Carvi, Pouliot, Menthe, Camomille, Valeriane, Laurier-cerise, Hyssope, Citron, Bergamote, Sauge, Genievre, Roses, Romarin.

eight tenths of an inch in diameter, and containing a mixture of lime and water. A lamp heat being now applied to the matrass, until the whole length of the tube passing from it becomes warm, chlorine will be formed, and absorbed by the lime, which will thus be converted into a chloride of lime. This solution of the chloride is then to be diluted with water, until its quantity be 2.113 wine pints, and its strength is then to be ascertained.* This will determine the quantity of pure peroxide contained in the portion examined; since, if the solution be found to have contained 0.9 its volume of chlorine, the quantity of pure oxide will be 0.9 of the portion examined, *and the number* 0.9 *will represent the purity of the specimen.* To ascertain how much hydrochloric acid has been expended but not converted to chlorine, it is necessary to subtract from the whole quantity employed, that converted into chlorine and chloride of manganese. Now the quantity of chlorine liberated is precisely the same as that absorbed by the protoxide of manganese, in the form of hydrochloric acid; and one part of pure peroxide of manganese completely decomposes 1.628 of pure and dry hydrochloric acid. Consequently, to know the quantity of acid decomposed by the pure peroxide alone of any specimen, we have only to multiply the number 1.628 by the number representing the purity of the specimen.

The quantity of hydrochloric acid originally poured upon the oxide includes that converted to chlorine, besides the portions which combine with the protoxide of manganese and its various impurities, and with the lime. To determine the quantity of absolute acid in this, take a similar quantity of the same, and after moderate dilution, add a known weight of marble. The quantity of marble dissolved will indicate the quantity of dry acid; one hundred grains of marble corresponding to seventy-four grains of absolute acid.

Repeat the first part of the process already given for ascertaining the quantity of chlorine furnished by the oxide; but observe that the gas must be received into water; instead of the mixture of lime and water used in the first instance. Then add the water which has re-

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* This is known by the quantity of the sulphuric solution of indigo the color of which it can destroy. The solution is made by finely pulverizing good indigo, sifting it through silk, and heating it for six or eight hours on the sand bath, with nine times its weight of sulphuric acid sp. gr. 1.848. We must then ascertain how much chlorine is required to destroy its color, and carefully dilute it just so far that the color of ten volumes will be destroyed by a solution containing one volume of chlorine.

ceived the chlorine, to the liquid still remaining in the retort, and put into the mixture a known weight of marble. The quantity of marble dissolved will indicate, as before, the quantity of free acid. If this be taken from the quantity of real acid poured upon the oxide, we have the quantity absorbed by the oxide and its impurities; and if from this difference we subtract the quantity of acid decomposed by the peroxide alone, (a quantity known by the ascertained purity of the specimen) we shall know how much has combined with the impurities of the mineral. The artist will consider this last quantity as so much acid lost, and will add it to the price of the oxide.

This process is long and difficult, and it is much to be desired that some simpler process could be employed to determine the quality of a substance so extensively used. On enumerating the substances to be found in the native oxide, it will be observed that none of them yield oxygen when treated with sulphuric acid, and therefore that the whole of the oxygen afforded by the common process, proceeds from the manganese. Hence, the quantity of oxygen obtained by the action of sulphuric acid upon any specimen, should be in direct proportion to the quantity of pure peroxide which it contains. As 44 grains of pure peroxide afford, when treated with sulphuric acid, almost precisely 23.6 cubic inches of oxygen gas (therm. 60° and bar. 30 inches) it will be easy to ascertain the purity of any natural oxide, and consequently the quantity of chlorine it will yield when treated with hydrochloric acid. Such are the conclusions which, from our theoretical views, we think it fair to draw; and we do not know any principle in opposition to them. It is true that carbonic acid gas will frequently accompany the oxygen, but it will be absorbed by the water of the pneumatic trough, to which, if requisite, lime might be added. At some future opportunity we shall perform and publish some experiments on the subject; giving, at the same time, the mode of ascertaining the quantity of acid neutralized by the impurities commonly mixed with the mineral. In conclusion, we would observe that chemists and mineralogists do not specify whether the iron in manganese ores exists as a peroxide, or as a protoxide. In order to test the practicability of the plan above suggested, it will be necessary to determine this point, and to know whether the oxide of iron takes any oxygen from that of manganese, when an acid is poured upon a mixture of the two.

Peroxide of Mercury; Red Precipitate.—This substance is adulterated with various red powders, among which are the deutoxide

of lead, and powdered brick. Such frauds, however, are easily detected by heating to low redness a portion of the oxide; by which process the mercury and the oxygen are separated and volatilized, while the other substances remain fixed at that temperature. Should vegetable matter have been added to the oxide, the latter will afford carbonic acid when heated; or, if mixed with water, the oxide will sink rapidly, while the vegetable matter will float for a longer time. As the red precipitate of commerce is prepared by cautiously heating the nitrate of mercury, it almost always contains a portion of undecomposed nitrate from which it should be freed, by exposure to a heat gradually increased until it ceases to evolve nitrous vapors, and gives off good oxygen.

Peruvian Bark.—The physical characters of the various species met with in commerce, being detailed by authors easily accessible to our readers, we shall dwell rather upon the chemical researches connected with the subject.* The external appearances not being always satisfactory, it sometimes becomes necessary to resort to chemical analysis, to determine the quantity of quinine contained in the bark, and its consequent value as a medicine. M. Tilloy recommends the following process; add one ounce of the bark in coarse powder, to twelve ounces of alcohol sp. gr. ·867, and at the temperature of 120°. After digesting for half an hour, decant the alcohol, and repeat the process; observing to press the bark after decanting the second portion. Mix the several portions of alcohol, filter and add a solution of bi-acetate of lead as long as a precipitate falls. Then filter the solution, which contains acetate of quinine, and add cautiously sulphuric acid, as long as a white precipitate falls. This precipitate is sulphate of lead; and does not occur at all, unless a slight excess of the bi-acetate has been used in the former part of the process. When the sulphate of lead ceases to fall, add a little more sulphuric acid, in order to convert the acetate of quinine into a sulphate. Then filter and distil.† We thus obtain sulphate of quinine and a fatty matter which adheres to the sides of the vessel. Decant, and add just enough ammonia to precipitate the whole of the quinine. Wash the precipitate with warm water, and dissolve it in very dilute sulphuric acid containing an admixture of animal charcoal; by which means we shall obtain, on the first

* See observations and experiments on Peruvian Bark, by G. W. Carpenter, Vol. XVI, p. 28 of this Journal.

† It should be stated how far the distillation is to be carried.

crystallization, a very white sulphate. By this process M. Tilloy obtained nine grains of sulphate from an ounce of bark; but the common process, on a large scale, affords a greater proportion.

Among the frauds committed by the venders of bark, is that of selling the article after having extracted the quinine. The quinine being first removed by sulphuric and hydrochloric acid, and the residue washed with very dilute ammonia, the bark is dried, mixed with good specimens, and sold. It is stated by M. Chevallier, that the yellow varieties, after being thus treated with *sulphuric acid*, assume a brown color approaching that of tobacco; their taste becomes less bitter, and somewhat saline; and particles of sulphate of ammonia may be detected by a magnifying glass. The gray varieties also assume a brownish color, and a saline taste. The color of the red bark becomes much more intense, and the saline taste is more developed than in the other varieties.

Phosphate of Soda.—The mode of preparing this salt as we find it in commerce, renders it extremely difficult to procure it in a state of perfect purity; and indeed it is not required to be so, when employed as a medicine. It is sometimes, however, largely adulterated with sulphate of soda; and may contain a portion of free carbonate of soda; both of which would change its action on the system, and impair its value. The phosphate of soda, when crystallized, should lose by exposure to heat, 61·71 per cent. of water.* Its crystals efflorescence rather slowly; while those of the sulphate of soda undergo the same change rapidly. The sulphate is neutral, while the phosphate gives the syrup of violets a green color.† The phosphate has a faint saline taste, without any bitterness: while the sulphate is very bitter. If we take Thomson's analysis as correct, a solution of 168 grains of the crystals will give, when completely precipitated by nitrate of barytes, 106 grains of phosphate of barytes, which should be entirely soluble in pure nitric acid. Should any portion of the precipitate be insoluble in nitric acid, it may be considered as sulphate of barytes, 118 grains of which indicate 162 grains of crystallized sulphate of soda. Should the precipitate effervesce when dissolving in nitric acid, it may be considered as containing carbonate of soda; the quantity of which may be determined as follows: Dissolve all the soluble part of the precipitate in nitric acid; thus obtaining a

* Thomson says 64.285+

† By care, and on a small scale it may be made quite neutral.

solution of phosphate and nitrate of barytes. Precipitate the phosphate by pure ammonia, filter, and add to the fluid, carbonate of ammonia, by which we shall precipitate carbonate of barytes, 100 grains of which indicate 144 grains of crytallized carbonate of soda.*

Soda.—The carbonates of soda met with in commerce are very variable in their composition; some of the fine crystals being nearly pure, while the coarser preparations are largely mixed with a variety of substances. The mode of examination usually applied to the carbonates of this alkali and of potash, are founded on their power to neutralize acids. As, however, the process is described in the popular works on chemistry, we shall not repeat it in the present instance, but will proceed to mention some impurities which are liable to influence the neutralizing power of the carbonate, and therefore to interfere with the accuracy of the results obtained by the usual examination. In testing the solubility of specimens made from the sulphate of soda, it is better to dissolve them in cold than in hot water; since the latter dissolves more readily the sulphuret of lime, which then reacts upon the carbonate of soda, converting it into a hydrosulphuret,† and precipitating carbonate of lime. The presence of the sulphite and of the hydrosulphuret also tends to create error, as they neutralize a portion of the acid used as a test, and thus raise the apparent neutralizing power of the carbonate beyond its real power. This disadvantage is avoided by mixing the carbonate with one fifth or one third its weight of chlorate of potash, and exposing the mass to a red heat, in a platina crucible. The sulphuret and sulphite are thus converted to sulphates, which cannot combine with any portion of the acid used in the examination. If the specimen to be examined be very impure, and contain much insoluble matter, it will be best to dissolve all the soluble portion, add the chlorate to the solution, evaporate to dryness, and then proceed as before.

When, on pouring sulphuric acid into a solution of any of the carbonates of commerce, there is a simultaneous disengagement of sulphur and sulphurous acid, the presence of the hyposulphite of soda is indicated. This salt, however, does not affect the neutralizing power of the specimen in which it exists, since its base cannot combine with any acid, without separating from that with which it is already

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* The quantity of water of crystallization varies somewhat, according to the temperature at which the crytals are formed.

† We are not satisfied as to the nature of this solution.

united; which last though partially or wholly decomposed, will act upon vegetable blue colors.* We must not attempt to convert this hyposulphite to a sulphate, by chlorate of potash, because more sulphuric acid will be formed than the base of the hyposulphite can saturate: and this excess, acting upon the carbonate, will diminish the apparent saturating power of the specimen.

Sulphate of Magnesia.—This salt is liable to be mixed with sulphate of soda, which has even been substituted for it. When the latter is the case, the fact is easily discovered, by adding an alkaline carbonate to a solution of the salt; from which, if it be sulphate of soda, no precipitate will occur. When the two salts are mixed, it becomes necessary to ascertain the quantity of magnesia contained in any given weight. For this purpose dry some of the salt by exposure to a heat below redness, and dissolve 120 grains of the dried mass in boiling water. Add to the solution a small excess of carbonate of soda, and continue boiling for some minutes. The precipitate being washed, dried, strongly calcined, and weighed, gives the quantity of magnesia; which should be 40 grains. The quantity actually obtained will, however, be somewhat less; as the alkaline carbonates do not completely precipitate the magnesia. This slight error may be avoided by employing pure potash as the precipitant, instead of carbonate of soda. To obtain a more direct proof of the presence and quantity of the sulphate of soda, dissolve a known weight of the salt in water and add a solution of hydrochlorate of barytes, in just sufficient quantity to precipitate the whole of the sulphuric acid; observing to add no more when it ceases to form a precipitate. Filter, wash the precipitate, add the washings to the filtered liquid, and evaporate to dryness. Pour alcohol upon the dry mass. The hydrochlorate of magnesia will be dissolved, while common salt will remain; very little being taken up by the alcohol, if the latter be pure. Sixty parts of common salt, when dry, indicate seventy-two of dry or one hundred and sixty two of crystallized sulphate of soda.

Sulphate of Quinine.—The high price of this article has led to its adulteration with several substances. It should consist of delicate, white, silky crystals, having a very bitter taste, and soluble in thirty parts of boiling water, or seven hundred and forty parts of cold water. With potash, soda, and ammonia, it yields a white,

* Probably the effect of sulphurous acid.

flocculent precipitate, partially soluble in an excess of alkali. Tartaric, oxalic, and gallic acids, and tincture of galls, give precipitates soluble in excess of acid.

The sulphate of lime artificially crystallized, closely resembles that of quinine, and has been frequently mixed with it. The fraud may be detected by burning the salt in a crucible; when, if any gypsum be present, it will not be consumed. The quantity lost in burning gives the weight of the pure sulphate, provided no vegetable matter has been added to the mixture.

Stearine has been used as an adulteration; but it is easily recognized by its insolubility in dilute sulphuric acid, on the surface of which it floats. When the fluid is heated, the stearine assumes the form of transparent drops, which again become opake on cooling.

The presence of sugar may be discovered, by dissolving the sulphate in water, and precipitating by carbonate of potash, observing to avoid an excess of the carbonate. The filtered solution being now evaporated sufficiently, the taste will become evident; or the evaporation may be carried to dryness, and the sugar dissolved by alcohol. This process, though effectual, seems superfluous. Would it not be sufficient to wash the sulphate with twice its weight of cold water, and evaporate the fluid to dryness? This should dissolve all the sugar, but a mere atom of sulphate; surely not enough to mask the sweetness of the mass. The above process is applicable also to sugar of manna (mannite).

The existence of sulphate of cinchonine in that of quinine, is not so apt to be detected, as the preceding adulterations. To ascertain whether or not it be present, dissolve the salt in very dilute sulphuric acid, and evaporate at intervals, as long as the liquid affords crystals of sulphate of quinine. Add to the remaining liquid, which does not crystallize, a little carbonate of potash; then treat the resulting precipitate with alcohol, and evaporate slowly. If sulphate of cinchonine has been present, the alcohol will afford cinchonine in crystals having a bitter taste, insoluble in cold water, soluble in alcohol, and restoring, when thus dissolved, the blue color of vegetable matter reddened by acids.

Super-tartrate of Potash; *Bi-tartrate of Potash.*—This salt, as found in commerce, always contains a portion of tartrate of lime, which sometimes amounts to six per cent. This is an accidental impurity, and not an adulteration. It has sometimes been intentionally mixed with marble, and even with pulverized silicious stones.

For the purpose of detecting these additions, boil the salt in twenty times its weight of water, adding pure ammonia to neutralize the excess of acid. If any portion remain undissolved, it may be considered an impurity; and if it be soluble with effervescence in hydrochloric acid, it is carbonate of lime.

Tartrate of Potash and Antimony.—Tartar emetic sometimes contains an admixture of cream of tartar. To ascertain the presence of this salt, dissolve one part of the tartrate in four of water, and observe whether or not it precipitates a solution of the hydrochlorate of barytes, the oxalate of ammonia, or the acidulated solution of the bi-acetate of lead. The last, which is a very delicate test, is prepared by dissolving eight parts of crystallized bi-acetate in thirty two parts of hot water, filtering the solution, and adding fifteen parts of acetic acid sp. gr. 1.064. The precipitate does not always occur immediately. Tartar emetic prepared from glass of antimony is apt to contain tartrate of iron; the presence of which is to be discovered by the usual tests of iron. The crystallized tartar is the purest.

Vinegar.—The strength of this acid varies; but when of the average strength, one hundred parts dissolve eight parts of carbonate of lime. Various acrid substances are sometimes put into weak vinegar, to give intensity to its taste; but it is observed that when such vinegar is neutralized by carbonate of potash, it still retains its taste; which is not the case when the vinegar is pure.

To detect the presence of sulphuric acid, which is one of the worst adulterations, evaporate the vinegar to one eighth its original volume, and observe whether its acidity be not increased. Add to the concentrated liquid five times its volume of alcohol sp. gr. .837, filter, add an equal volume of water, evaporate until most of the alcohol is removed, and add a very dilute solution of nitrate of barytes. This, if sulphuric acid be present, will afford a precipitate insoluble in nitric acid.

To determine the presence of hydrochloric acid, distil a portion of the vinegar, and add to the distilled liquid nitrate of silver; which gives, with hydrochloric acid, a precipitate insoluble in nitric acid, but soluble in ammonia. The nitric acid is detected by neutralizing the vinegar with carbonate of potash, crystallizing, and applying the common tests by which nitrate of potash is easily recognized.

When vinegar contains oxalic or tartaric acid, it yields these substances in crystals when evaporated, and their characters will correspond with those detailed in the popular books on chemistry.

When vinegar has been ascertained to be free from other acids, its strength may be known by observing the quantity of carbonate of lime dissolved by a given measure.

Some kinds of vinegar contain a considerable quantity of cream of tartar, which separates in crystals when the liquid is evaporated to a small compass.

Vinegar, even when distilled, contains a little vegetable matter, which becomes perceptible when the acid is neutralized by alkali, and allowed to stand for some weeks. In testing distilled vinegar for foreign matters, the tests may be applied immediately to the vinegar, without the intervention of alcohol, as in a preceding instance.

The detection of the mineral acids in lemon juice, must be attempted in the same way as in the case of vinegar; applying the tests to the filtered juice, or, when testing for hydrochloric acid, to the liquid obtained by distilling the juice.

We have now reached the limits which we had proposed to ourselves in commencing the present paper. In detailing processes, we have preserved, generally the form, and always the principles adopted by our authors. Wherever we have differed from them, we have been careful to state the grounds on which our views were founded, and we have avoided too positive a tone, in those instances in which we have not verified our doctrines by actual experiment.

On a careful examination of the work of MM. Bussy and Boutron-Charlard, we are induced to form a very favorable opinion of it, as presenting a fruitful source of valuable and even essential knowledge, which cannot be obtained in our own language, without much expense of time and labor. It occupies five hundred and seven pages octavo, and being arranged in the form of a dictionary, is much more convenient, as a book of reference, than it could be, if possessing a more scientific form. It is true that the subject might be treated in much more elaborate manner; new compounds might be introduced, and some of those treated of might be more fully illustrated; but until such a work shall appear, we would recommend that in question; confident that it will materially advance a branch of science, in which the physicians of Europe as well as of this country are deplorably deficient.

Art. XII.—*Notice of the Academy of Natural Sciences of Philadelphia; by a Member.*

Natural History in its present state, may be compared to a Temple, beautiful in its materials and proportions, yet in many parts unfinished, while innumerable architects are engaged in completing it. The nations of Europe vie with each other in this fascinating toil; and it may be confidently asserted that they have found in America, an able coadjutor.

What has been the result? To say that confusion has been restored to order, would be doing injustice to Nature: let us rather say that man has at length *discovered* the harmony, connexion and dependence which characterize the works of Providence; he sees that every object in nature is a link in creation, and that no one thing is wholly insignificant or useless.

But Natural History, however ennobling and delightful to the mind, has hitherto been retarded in this country by various adverse circumstances. It was thought to add nothing to the wealth of him who pursued it; and was too little appreciated, by the mass even of intelligent men, to secure to its cultivators that acknowledgment to which they have so fair a claim. A change, however, has commenced in this particular; and Natural History is beginning to assume its proper place among useful sciences: the Physician and the Chemist find it indispensable to their respective pursuits; the traveller, by its aid, gleans instruction and amusement in the most inhospitable solitudes; it is becoming the fire-side recreation of both sexes; even the sordid man invokes its assistance; and every one may reap abundant gratification to requite him for the time and labor he may bestow upon it.

Without further preface we propose to introduce the reader to some acquaintance with the "Academy of Natural Sciences of Philadelphia;" for we are aware that this institution has many members both in Europe and America, whose remote situation will render the following details doubly interesting; while they will be more or less gratifying to every friend of science.

The Academy originated on the 25th of January, 1812; at which time a few gentlemen, (among whom was Mr. Thomas Say,) resolved to meet once in every week for the purpose of receiving and imparting information. Even at that late period the study of Natural

History was, in this country, confined to a few zealous individuals; and although several societies had been organized for concentrating the scientific talent and enterprise of Philadelphia, their duration was for the most part ephemeral. About this period Natural History received a permanent impulse from the appearance of Wilson's "American Ornithology" and from the personal exertions and published tracts of Dr. Benjamin Smith Barton. Botany, so ably illustrated by the ardor of Dr. Muhlenberg, had many votaries at the time we allude to: among the most zealous of these were Mr. Z. Collins, Mr. Nuttall, the late Dr. Waterhouse,* &c. Mr. Say was indefatigable in several branches; Mr. Ord was devoted to Zoology; Mr. Godon, Mr. Conrad and some others were active in exploring the mineral resources of this vicinity; Mr. Maclure was assiduously engaged in Geology; whilst many others, who have since become distinguished for their scientific acquirements, were then just venturing on the threshold of inquiry.

Most flourishing institutions have had their probationary difficulties and discouragements. The Academy was for some time located in a very disadvantageous situation, and may even be said to have struggled for an existence. Books and collections of natural objects, those indispensable parts of such an establishment, accumulated but slowly; and money, that *primum mobile* of human achievments, was sparingly at the disposal of an embryo institution. At this juncture the Academy found a truly munificent friend in Mr. William Maclure. This gentleman had amassed a handsome fortune in mercantile pursuits; and being posessed of an acute mind and extensive scientific acquirements, he now attached himself to the Academy with a zeal and liberality which have few examples on record. During a protracted visit to Europe, he assiduously collected a great number of scientific works which he presented to his favorite institution. He traversed the continent of Europe from Italy to Sweden, and in every situation found something to aid the cause of science and feed the ardor of his mind. In these fruits of unwearied personal industry the Academy shared largely; and its present valuable collections may be said to have mainly originated in the contributions of Mr. Maclure. It is but justice, however, to observe

* Dr. Waterhouse was the first person who gave popular lectures on Botany in Philadelphia.

that from the commencement of the society its members have been characterized by untiring zeal and industry; and that their unostentatious but effectual exertions in the cause of science, were the great incentives to Mr. Maclure's subsequent liberality.

The Academy was incorporated in 1817; about which time the publication of the "Journal" was commenced. From that period its permanence and prosperity may be dated. Its location though not the most desirable, was respectable, and in some respects convenient; and its collections of books and specimens augmented rapidly. It was soon found necessary to provide more extensive accommodations than those hitherto enjoyed, and in the spring of 1825 the Academy purchased the spacious building they now occupy, and have spared no expense in adapting it to their purposes.

This building, which was originally designed for a place of worship, is situated at the corner of Twelfth and George streets: it is a quadrangular, stuccoed brick edifice, about forty four feet square, and surmounted by a dome. It has no partitions, but presents a single saloon, with a gallery eight feet broad traversing the wall on all sides midway between the floor and ceiling. The light is admitted from the dome, and from six side windows above the gallery.

The lower part of the building is occupied chiefly as a Library and meeting-room, while the gallery is devoted to the collections. The latter are displayed in upright cases against the walls, and in horizontal cases against the railing of the gallery. The objects are arranged in accordance with the most approved systems; and their generic and specific names and localities, together with the names of the donors, are conspicuously attached to each. The attention which is paid to these particulars renders the cabinet of the Academy not only pleasing to the eye, but very satisfactory for reference; and it is obvious that without such care the most splendid collections are productive of more disappointment than gratification to the beholder.

To render these collections extensively useful, and to diffuse the love of science in every class of the community, the Academy about two years since passed a law rendering its museum accessible to the public; and it is now opened to the *gratuitous* admission of citizens and strangers on the afternoons of Tuesdays and Saturdays throughout the year.

The meetings are held every Tuesday evening; they are open to strangers excepting the last meeting in each month, which is re-

served for the private affairs of the institution. The other, or ordinary meetings, are devoted to the reading of scientific papers, verbal communications, the receiving of donations, &c. &c.

The present number of resident members is about sixty. The list of correspondents is much more numerous, and embraces a large proportion of the eminent scientific men in all parts of the world.

The library contains upwards of two thousand two hundred volumes on scientific subjects, exclusive of maps, portfolios of engravvings, &c. The collection is constantly augmenting by purchases, donations and exchanges, and embraces very many of the rare and standard works on the natural sciences. A large proportion of these, as already observed, were selected in Europe by Mr. Maclure, and by him presented to the institution. Exclusive of the scientific works are upwards of a thousand volumes on subjects foreign to the immediate objects of the Academy: most of these were also presented by Mr. Maclure.

The "Journal of the Academy" was commenced in the year 1817. This work is chiefly confined to brief and technical statements of *discoveries* in Natural History; in other words, that which is not *new* (or believed to be so) is not admitted into its pages. A periodical restricted within such bounds must necessarily be chiefly interesting to scientific persons, among whom it is widely circulated in America and Europe. It is replete with important details in every branch of Science, and probably contains a greater body of facts in reference to the natural history of this country than any other work. Five octavo Volumes have already been published, and the sixth is nearly completed; and perhaps a better idea of their plan and purpose cannot be conveyed than by quoting a part of the preface to the first volume:

"In further pursuance of the objects of their institution, the Society have now determined to communicate to the public such facts and observations as, having appeared interesting to them, are likely to prove interesting to other friends of Natural Science. They do not profess to make any periodical communication; but well knowing how desirable it is that persons engaged in similar pursuits should be made acquainted as early as possible with what has been done by their fellow-laborers in the fields of Science elsewhere, they mean to publish a few pages whenever it appears to them that materials worthy of publication have been put in their possession. In so doing, they propose to exclude entirely all papers of mere theory,—to con-

fine their communications as much as possible to facts,—and by abridging papers too long for publication in their original state, to present the facts thus published clothed in as few words as are consistent with perspicuous description."

The views expressed in the preceding paragraph have been strictly comformed to; in consequence of which the journal continues to be issued when *original* papers are offered, without reference to any precise interval. Among the contributors to the *Zoological* department we may mention the names of Mr. Say, Prince Charles Lucian Bonaparte, Mr. Leseur, Mr. Ord, Dr. Harlan, Mr. Wood, Dr. Green, Dr. R. Coates, Dr. S. L. Mitchill, Mr. Hentz and Dr. Godman.

The *Botanical* communications are chiefly from Mr. Nuttall, Mr. De Schweinitz, Mr. Stephen Elliott, and Mr. S. W. Conrad. *

In *Geology and Mineralogy*, many papers will be observed from the pens of Mr. Maclure, Mr. Nuttall, Mr. Vanuxem, Mr. Keating, Dr. Troost, Mr. J. P. Wetherill, Mr. T. Bowen, Mr. T. A. Conrad, Mr. H. Seybert and Dr. S. G. Morton.

We next propose, as a part of the task we have attempted, to offer some brief particulars in reference to the *collections* of the Academy, in the various departments of science. These collections, it is obvious, will not bear a comparison with those of the great European museums, many of which have been established and fostered by the patronage of national governments: but we trust the reader will bear in mind that the Academy has been but a few years in existence; and that its present collections and other property have been derived exclusively from the liberality, talents and industry of private citizens. These facts induce us to give an honest summary of the Academy's collections; not doubting that their deficiences will from time to time be provided for, as heretofore, by the exertions of members, and others interested in the advancement of science.

For the purpose of convenience, the collection may be divided into three classes: 1. Zoology; 2. Botany; 3. Geology and Mineralogy.

Zoology.—The constant attention required by Zoological subjects, and the space necessary to their proper exhibition, are difficulties in the way of extensive collections which few institutions can provide for. Hence the Academy has but recently attempted to

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* Now Professor of Botany in the University of Pennsylvania

make systematic collections of Birds and the larger Quadrupeds. Among the latter, at the present time, are but a small number of native and still fewer foreign animals. Arrangements, however, are making to extend this department which will no doubt hereafter receive its full share of attention.

Perhaps no one of the Natural sciences has been more assiduously cultivated by the members of the Academy than *ornithology.* This observation is established by a reference to the splendid works of Mr. Alexander Wilson, Mr. George Ord and Prince Charles Lucian Bonaparte. These gentlemen have widely diffused a taste for this elegant study, but have in truth, left little to be divulged by future inquirers. The collection of Birds in the Academy is not yet extensive, and the number of species does not exceed five hundred; among which however, are many rare and beautiful specimens. Among the larger birds are the male and female Condor, (Vultur gryphus) from South America. The Eagle of Washington (Falco Washingtonianus) recently described for the first time by Mr. Audubon. Another bird rare in American collections is the *Bengal Adjutant*, an adult and very finely characterized individual. The Academy has lately become possessed of a splendid collection of the birds of Surinam, and the adjacent continent and seas, presented by Dr. Hering of that province. The collection embraces upwards of two hundred and fifty species, most of which were procured by the personal exertions of the donor, and have been sent in admirable condition. They are now in progress of arrangement, and will constitute a beautiful monument of the zeal and munificence of Dr. Hering. This handsome present has already stimulated the members to additional exertions in the department of Ornithology; and it is confidently believed that in the course of another year the Academy will be in possession of nearly all the species of birds inhabiting the middle Atlantic states.

The collection of *Fishes* embraces many rare species, and is rapidly augmenting. The *Reptiles* are numerous, and include a large proportion of the known American species of Testudo, Salamandra, Rana, Coluber, &c. &c.

The cabinet of *Shells*, which is arranged in horizontal cases, presents one of the most ornamental portions of the Academy's museum. The species exceed twelve hundred, each placed on a plaster pedestal, with the generic and specific names affixed. A very interesting part of the series is formed by the Fresh water and Land shells, collected by Col. Stephen H. Long in the western States, and

by him presented to the Academy. In this department the classification of Lamarck is exclusively followed.

The *Insects* are numerous, especially the Lepidoptera. Great difficulty, however, has been found in preserving them; and several successive collections have been destroyed by damp, or by the inroads of predaceous insects. But it gives us much pleasure to state that a valuble cabinet of upwards of four thousand species, (two thirds of which are American) chiefly collected by a member of the Academy, will be presented to the institution so soon as effectual means can be devised for its exhibition and preservation. With the Birds presented by Dr. Hering were four hundred species of insects, in fine order, from the province of Surinam. The *Crustacea* and *Zoophytes* embrace a valuble series of American species.

Botany.—The Academy possesses about ten thousand species of plants, among which is a choice American Herbarium collected by Mr. Thomas Nuttall. This gentleman is well known to have been for many years ardently engaged in Botanical researches: he has traversed the United States and Territories in almost every direction,—the courses of the Missouri and Arkansa rivers,—the great Lakes,—Carolina, Georgia, Louisiana, &c. &c. In the prosecution of his travels Mr. Nuttall collected and carefully preserved upwards of four thousand species of plants, all of which are now embraced in the Academy's Herbarium.

Accompanying Dr. Hering's recent donation of Birds, is an extensive collection of the plants of Surinam: their number (probably some thousands) is not yet ascertained. Mr. De Schweinitz has them at present at his residence in Bethlehem, Penns. for the purpose of labelling and arranging them.

There are also small collections from the Andes, from Southern Africa and India. The European collection, presented mainly by Mr. Maclure, is both extensive and valuable. To conclude this part of our subject we record with pleasure, that the present proprietor of the Botanical collection of the late Dr. Baldwin, has intimated his intention of adding it to the Herbarium of the Academy.

Geology and Mineralogy.—The Geological series is perhaps the most complete of the Academy's collections. It comprises about four thousand five hundred specimens, of which two thirds are fossil organic remains of animals and plants. The fossils are all arranged according to the formations in which they occur, and consequently afford matter of great interest to the geologist. The different suites may be enumerated as follows;

1. A series of the rocks of Europe, Primitive, Transition and Basaltic; collected between Naples and the north of Italy, and thence through Germany to the Baltic Sea, by Mr. Maclure and by him presented to the Academy.

2. Rocks of several of the West India Islands: collected and presented by the same gentleman.

3. Series of the Greenstone rocks of Scotland. Collected and presented by S. G. Morton, M. D.

4. Rocks from the northern shore of Lake Superior. Presented by Zina Pitcher, M. D. U. S. A.

5. Rocks from the route of the Erie and Hudson Canal. Presented by the Hon. Stephen Van Rensselaer, of Albany, N. Y. Besides the preceding are several smaller series of rock formations and many insulated specimens.

6. A series of Vegetable and other impressions from the coal districts of Pennsylvania, Virginia, Ohio and Rhode Island.

7. An extensive collection of fossils from the secondary Limestone region of the Valley of the Mississippi, including the entire collection of the late Mr. Clifford, of Lexington, Ky. deposited in the Academy by Mr. John P. Wetherill.

8. One thousand British fossils, being the entire collection of the late Mr. Steinhaur, and deposited in the Academy by Mr. John P. Wetherill.

9. A series of fossil shells, illustrating all the formations of the Paris Basin, and arranged according to the system of Mess. Cuvier and Brongniart.

10. Several hundred very perfect fossil Shells, Crustacea and Zoophytes, illustrative of the secondary formation of New Jersey, known as the *Marl region.*

11. An extensive series of the Tertiary fossils of Maryland, Virginia, &c. &c. embracing an hundred species and several hundred specimens.

12. Series of the bones and teeth of the Mastodon, collected in various parts of the United States, and especially in the valley of the Mississippi. A large proportion of these are deposited by Mr. Wetherill. Forming a part of the same collection are ten huge teeth and some bones of the fossil American Elephant, chiefly obtained from the valley of the Mississippi. Also parts of three skeletons of the Megalonyx from the same country: these comprise several ribs, vertebræ, bones of the leg, foot, &c.

The *Mineralogical* cabinet embraces a fine series of American minerals; among which are many beautiful specimens from Lockport, in N. Y. collected and deposited by Mr. Thomas Fisher. They consist chiefly of the carbonates and sulphates of lime, and the sulphate of strontian. The salts of lead from the Perkiomen mine are probably the finest hitherto obtained from an American locality. The European collection is also well chosen, though deficient in some classes. A large proportion of the foreign specimens was presented by the President of the Society, Mr. Maclure. A thousand choice specimens, constituting the collection of Dr. Thomas McEuen, were deposited by that gentleman with his characteristic liberality and love of science: Mr. Henry Seybert, Mr. Jos. P. Smith and others, have also of late contributed largely to this department. The mineral collection now embraces, collectively, about three thousand specimens.

Such is the present situation of the Academy of Natural Sciences; and while we feel an honest pride in recording the success of a favorite institution, our gratification is much enhanced by observing the collateral exertions which are making in almost every section of the Union to extend the boundaries of scientific information. The American Philosophical Society, perhaps the oldest of our Scientific and literary institutions, acting on the broad basis of "promoting useful knowledge" has done and is still doing a laudable share in the accomplishment of that great design, in which is included every branch of natural history. The New York Lyceum, established with similar views to the Academy, is not behind the latter in the talents and industry of its members, nor perhaps in the degree of its success. Its "Annals" published on the same plan with the Academy's Journal, are indispensable to the student of American Natural History, while its collections are already extensively numerous and valuable.

We might greatly expatiate on this pleasing subject, so fruitful in promise to the cause of Science. Suffice it, in conclusion, to observe, that there is reason to hope that in a very few years, every large town in the United States, will have a well organized institution for disseminating the knowledge of Natural History.*

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* The following is a list of the officers of the Academy of Natural Sciences for the year 1830. *President*, William Maclure. *Vice Presidents*, Z. Collins, Geo. Ord. *Corresponding Sec'y*, Reuben Haines. *Recording Sec'y*, T. McEuen, M. D. *Librarian*, Charles Pickering, M. D. *Treasurer*, Geo. W. Carpenter. *Curators*, J. P. Wetherill, G. Hays, M. D., T. R. Peale, T. McEuen, M. D.

ART. XIII.—*Notices of the Geology of the Country near Bedford Springs in Pennsylvania, and the Bath or Berkeley Spring in Virginia, with remarks upon those waters; by* Dr. H. H. HAYDEN.

TO THE EDITOR.

Dear Sir—HAVING had occasion to visit Bedford Springs (in Penn.) during the month of August, 1829, and having observed some peculiarites in the geology of that district of country, not hitherto described (to my knowledge,) I am induced to offer a few remarks on the subject, which, if they appear to possess any interest, you are at liberty to use as you may think proper.

The borough of Bedford is a growing and healthy place, the population of which may be estimated at about fifteen hundred. It is the seat of justice for Bedford county, Pennsylvania, and is situated a few miles east of the principal elevation of the Alleghany Mountains, on the great western turnpike, which passes from Philadelphia to Pittsburg. In approaching Bedford from the east, we pass, on the margin of the Juniatta, through a deep gorge which divides a bold and extensive ridge called Derming's Mountain, a subordinate member of the Alleghany, and runs nearly parrallel with it. This mountain appears, at least in that region, to be composed of a sandstone, or what some perhaps, would denominate millstone grit.

On the west side of the valley in which Bedford lies, another bold and extensive ridge, likewise a branch of the Alleghany, runs parallel with Derming's, and is called Wills Mountain. Not having had an opportunity of visiting this range of mountains, I can say nothing of its geological structure. The whole region however, may, I believe, be considered as secondary.

At the distance of one mile south of the town of Bedford, we pass between two round hills of about one and a half miles in length, at their base, and of an elevation of about four or four hundred and fifty feet. Between them lies a valley, through which runs a copious stream called "Shover's creek" and which discharges itself into the Rays-town branch of the Juniatta river at the distance of one mile east of Bedford.

The hill on the east side of Shover's creek, (and valley) is called Constitution hill, and at its base arise, within a short distance, the

following medicinal and other fountains, viz. Anderson's, or the principal medicinal spring; Fletcher's or upper spring; the lime stone spring; the sweet springs; the sulphur spring, and the chalybeate spring. But for these springs, little would have been known respecting the geological structure of this mountain or hill, as the rocks scarcely appear at any point that is easy of access, the hill being very precipitous, particularly on the west side. The principal spring, however, issues, in a *copious* and perpetual stream immediately out of the rocks at the base, or at the height of about twenty or twenty five feet above Shover's creek, and within nearly the same distance of its margin. In order that the springs might be made easy of access and for the convenience of the numerous and highly respectable visitors that annually frequent this delightful place, this fountain of health, it became necessary to excavate the base of the hill, for the distance of about one hundred yards in length, for the purpose of making an agreeable promenade, at, and near the springs, and moreover for the purpose of erecting bathing houses and other buildings which stand immediately on the margin of the creek. In the prosecution of this work, a section of the rocks, of about one hundred and fifty feet in length, and about ten feet in height above the walk, was laid open to view. This, and all the northern part of the hill appears to be composed of lime stone lying in strata, from two inches to two and three feet thick, having a dip of forty or fifty five degrees to the south west. At or near the northern part of the excavation, there is a vein or stratum running into the hill, in which are presented several varieties of organic remains, (such are the specimens marked A, which I sent to you) and which as they lie at the foot of the hill, and, consequently, the lowest in the order of position, may be considered as amongst the inferior orders of organic remains; at least as they are here arranged.

At the distance of twenty or twenty five yards south, in the same section, and immediately opposite the south end of the building erected for baths, a second vein or stratum running into the hill, and of about six feet thick, is exposed to view. This stratum, unlike those that lie over and beneath, is the fetid carbonate of lime, and is filled with organic remains of different kinds, such as are marked B, amongst the specimens sent you. As most of these are of a character with which I am not familiar, I shall not now attempt to give them names or places, except that I consider them as belonging as before, to the lower order of organized substances. South of

this stratum, there are exposed to view, nine different strata, in which there are *no* appearance of organic remains.

At the distance of about one hundred yards south of this section of rocks, or from the principal spring which is very near it, we observe, although not in place, the first appearance of sandstone, which lies over the limestone. At the distance, however, of about one hundred and fifty yards south of the spring and at the foot of the hill, an excavation was made some years since for the purpose of obtaining materials for building the walls of a distillery, which is still standing by the side of a road running at the foot of, and over the southern slope of Constitution Hill to the neighboring district. The walls of this building are made of soft pulverulent sandstone, containing impressions of a variety of shells, as the producti, terebratulæ, a species of Pecten, &c.* These are the third deposits of organic remains that appear, at least, in the order of position. At a little distance south of the distillery, in the road and upon the surrounding surface, and *still* in the *sandstone* formation, we find abundance of the specimens marked C, and of various sizes from that of a quarter of a dollar to that of the palm of the hand.

From the above it must appear obvious, that the specimens marked A, (and which were obtained from a stratum of limestone at the very base or foot of the hill, and consequently the lowest in the series

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* I must beg leave, in this place, to call your attention to a fact mentioned in the "Geological Essays," page 50, respecting a deposit of boulders, &c. of various sizes lying in the city of Washington, a little north of the then United States Branch Bank. It is as follows. "Amongst these, I discovered in February, (1820,) rolled masses of amygdaloid, and of hornblende porphyry, containing epidote, both peculiar to the Blue Ridge or South Mountains, in Maryland and Pennsylvania, and which cannot be found in any place, perhaps, within sixty miles of Washington city. Moreover, among these rocks were some of a granular quartz, that would weigh, probably, from two to five hundred pounds, containing perfect impressions of shells resembling the terebratulite; this kind of rock, with like impressions, is not, I am credibly informed, to be found in place in a northern direction, short of Herkimer county, state of New York, or far beyond the North Mountains in Pennsylvania."

It is gratifying to me to have it in my power to add some corrections to the above statement, and to inform you that the ridges I am describing abound with the same kind of rocks, and in which are the same kind of impressions of organic remains. And, moreover, that these ridges continue their course south westerly to the Potomac River, down the course of which these boulders may have been carried together with the amygdaloids, &c. of the South Mountains, and deposited, as mentioned, in the diluvial formation in the city of Washington. Admitting the fact, and supposing the boulders to have been taken up or removed from the margin of the Potomac, they must have been transported more than one hundred miles.

of deposition,) were of an order very inferior in the scale of organized bodies, to those of C and D; and, consequently, as we ascend in the order of formation and position, the fossils present not only a greater variety, but become more and more complex and perfect in their structure and organization. Few localities present a more interesting subject for observation and contemplation than Constitution Hill, and it is principally on this account that I have considered it worthy of this notice. No one, on viewing the structure of this mountain or hill, and duly weighing the various phenomena will doubt that these deposits of organized substances must have taken place at epochs far distant from each other, and moreover, that the time required for their production, development, and perfection, must have been sufficient for the inception, growth, death and sepulture of these various races. This is demonstrated by the manner in which the young of various kinds of shell fish are produced, (especially the different species of univalves,) and by the diminutive size of the young when cast, as well as by the fact that not only different kinds are here presented to view, but that there are different sizes, especially of the univalves, some of them being more than twenty times longer than others, and having, in innumerable cases, reached their full perfection.

Having given a superficial sketch of Constitution Hill, I shall in the next place attempt a similar one of Federal Hill, on the opposite, or west side of the valley. This hill is nearly of the same dimensions at the base as Constitution Hill, but not of so great an elevation. Its geological structure is nearly the same, except that no veins of organic remains are perceivable. The southern slope is overlaid with sandstone, like the one on the east side of the valley, and in which are organic remains, the same as are observable at the distillery before mentioned. But I could find none of the specimens marked D. Organic remains are however, observable in the limestone by the side of the road, on the eastern slope and nearly at the foot of the hill, for a quarter of a mile from the springs. At this distance stands a grist mill, on the Shover Creek. Immediately opposite to this mill, and on the west side of the road leading to Bedford, the hill presents a vertical mural precipice of more than a hundred feet, and composed like the hill opposite, of stratified limestone. At the height of about thirty feet below the summit of this precipice there is likewise observable a vein of about two feet thick, and apparently filled with organic remains; but it being difficult of access without danger of

accident, I had not an opportunity of examining it. I however gained access to the lower part of the vein near where it was covered with earth, and from which I obtained two or three specimens. At the foot of this precipice, and by the road side may be found many interesting specimens that have probably rolled down from the heights above, but many of which have been mutilated or broken for the purpose of repairing the road. The rocks, from the mill to about a quarter of a mile above, run into a perfect slaty limestone.

I will now offer a few remarks on the various advantages which recommend this as an agreeable watering place.

I have observed that at the distance of one mile south of the town (or borough) of Bedford, we enter between two elevated hills. The road leading to the springs has a serpentine course on the eastern slope of Federal Hill and on the west side of Shover Valley. At the distance of one mile and a half from Bedford, we arrive at the springs, or at the several places of accommodation provided for visitors. These are situated at the base of Federal Hill and consist, in the first place, of two buildings, each two and a half stories high, and one hundred and thirty feet in length.

These buildings, although ample and convenient, having comfortable rooms, both for private families and for individuals, are not in the best taste, either in form or location; but when filled with good society, they will please even the valetudinarian; for in addition to the conveniences already mentioned, the north building has, in front, upon the valley and Constitution Hill, two spacious covered balconies, for ladies, and extending the whole length of the building; and the southern building has a similar covered balcony, for gentlemen; there is also a drawing room, of about twenty by twenty five feet square, besides a ball and dining room, nearly one hundred feet in length, where, through the liberality of the incumbent, Mr. Blackwood, every thing, whether useful or agreeable, is provided.

In front of this building, in the valley below, and enclosed within a handsome Chinese railing, there is elevated, upon a pedestal of rough masonry, a female figure, representing the goddess of health. From the stock passing through this statue, there issues a fountain of pure water, brought across the valley in pipes from the main spring, and which, when not disturbed by wind, falls into a bowl held in the hand of the goddess. This embellishment, although not in exact proportions, adds a pleasing and not uninteresting object in the midst of the surrounding scenery.

At the distance of fifteen or twenty rods south of the main buildings, there has been erected, but very injudiciously, and much to the injury of the prospect, as it is situated directly across the valley, a two story frame building, of one hundred and forty feet in length, intended for the accommodation of visitors. From the spacious balconies, however, in front of this building, the visitors enjoy an interesting prospect to the north.

The principal access from the several houses of accommodation to the springs, which, as before, issue from the foot of Constitution Hill, is by a raised way or walk, across the valley, to a small bridge, erected over Shover creek. From the springs, serpentine or rather zigzag walks are cut upon the western slope of Constitution Hill, to its summit, which, but for the towering forest trees, would afford, in *all* directions, a most interesting and highly romantic view. The valley between Federal and Constitution hills, and opposite Anderson's, or the principal spring, is in width about one hundred and fifty yards, and in its entire length almost a perfect level, the whole of which is beautifully interspersed with forest trees of natural growth, such as the oak, elm, maple, &c.

In fine, the bounteous and wonderful supply of water which flows from no less than seven highly medicinal and other springs, all within the radius of a stone's throw; the beauty of the valley and its susceptibility of the highest state of improvement; the lofty adjoining hills; and the extensive and beautifully romantic view from their summits to the north and east, present a combination of attractions hardly surpassed in this or in any country. Add to this the facility of obtaining all the delicacies and comforts of life, including wild and tame animals and vegetables of almost every kind and quality, and more than all, the high value of the perennial medicinal waters, which are not excelled in certain complaints by any in the world; all these circumstances combine to recommend Bedford springs, in Shover Valley, as a place of unrivalled attractions. It is much to be regretted that some individual or company has not, as yet, been engaged in rendering it what it is highly susceptible of being, the most inviting resort or public watering place in the United States.

On my return from Bedford springs, I passed by the way of Pigeon-cove Valley, across the narrow part of Maryland into Virginia, to Bath or Berkeley springs, so called, being in what was but recently Berkeley county. These springs issue from the foot and on the east side of an abrupt and elevated ridge, running in a north east

direction, about five miles, to the Potomac River, where it terminates, opposite the town of Hancock, Maryland. Little can be said in favor of the village of Bath, since, with the exception of a few buildings, it presents the appearance of dilapidation and ruins. The accommodations for visitors are, however, tolerable, at least for such as are not over fastidious. The springs, which are principally magnesian and justly celebrated, especially in chronic affections, and also the fine and spacious baths attached to them, constitute the principal inducement that attracts persons to this place. Indeed, such is their celebrity, that they are, annually, during the months of July and August, frequented, (and that too in no inconsiderable numbers,) by persons of the highest respectability.

As the object of this notice is, not so much a particular description of the springs and their many virtues, as a sketch of some of the Geological features which this district of country presents, I shall proceed to describe them.

The ridge above may be considered as a subordinate member of Cape Casson mountain, which lies about two miles west, and at the foot of which, for some distance, runs the south branch of the Potomac river. This elevated ridge, presents to view, on the east side, an almost perpendicular wall of sandstone, or millstone grit and such as would lead to the belief that the whole mountain was composed of the same materials. I found, however, by traversing the west side, that its sub-stratum was composed of limestone. This I was enabled to ascertain only by some excavations that had been made for the purpose of obtaining limestone.

The ridge, however, that bounds the valley on the east, and which runs parallel with the latter until interrupted by the Potomac river, near the town of Hancock, is of a very different character being composed, at least as far as I could ascertain, of silicious slate.

Previous to my visit to this place, I had been informed, by visitors, that organic remains, which the inhabitants of this village called petrified butterflies, had frequently been found in the rivulet running through the valley, and were supposed to be formed principally by the springs above mentioned. This stream I traversed down its course, without discovering any thing, until, at the distance of a quarter of a mile below the springs, I observed a quantity of stones recently driven from the natural channel of the rivulet, by an unusual flow of water produced by a heavy torrent of rain, and left upon a flat on its margin. Amongst these, I discovered impressions of various shells, en-

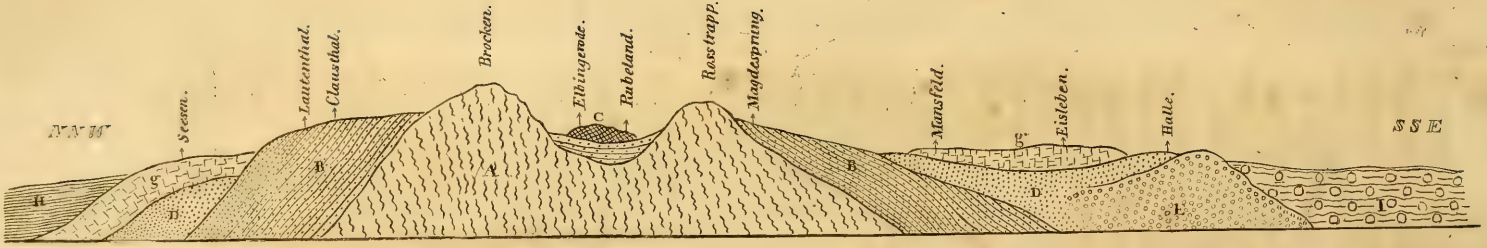
crinites, &c. Concluding that they must have come from a source higher up the stream, I retraced my steps a few rods, where I observed a ravine in which ran a small stream of water, over the rocks which appear to constitute the ridge of hills upon the eastern side of the valley. I had walked but a short distance up this ravine or run of water, before I discovered, in place, the specimens which I send you marked E. From these indications, and from information subsequently obtained, there is reason to believe that at the *base* of this ridge, and on or near the margin of the rivulet in its course to the Potomac river, there are strata or deposits of organic remains; as I was informed that at the foot of a mill dam situated lower down upon the same rivulet and nearer the Potomac, a variety of specimens of organic remains are to be found. I have also received information, from a source that I believe may be relied on, that the Trilobites, in fine preservation, have been and are still to be found higher up the rivulet or south of the springs, and which, probably, have been washed out of the same ridge; of this part, however, I was not aware when at the springs.

I have been thus, perhaps unnecessarily, particular that those who may hereafter visit this district, and who feel a pleasure in investigating subjects of a nature and character so interesting, may be led to the respective localities with the least trouble or fatigue.

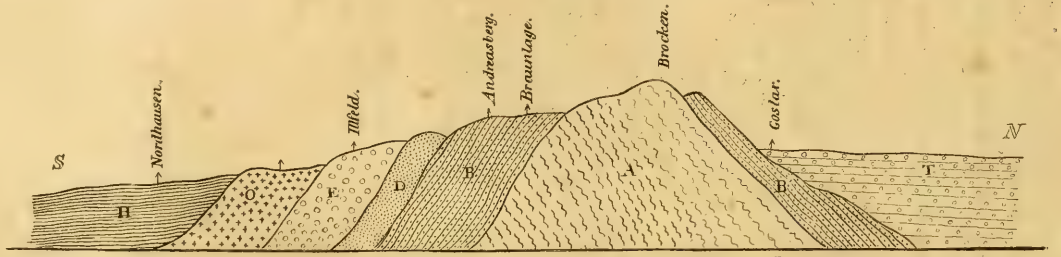
Remark by the Editor.

The organic remains mentioned by Dr. Hayden, are such as belong to the ancient secondary or transition. The specimens having been accidentally misplaced, I am not able to describe them more particularly, as requested by Dr. Hayden: I recollect, however, that several of them belonged to the ancient coralline and encrinital families; the petrified butterflies of the common people, it is well known, are trilobites, as Dr. Hayden has justly indicated.

A statement of the composition of the mineral waters which was expected has not been received.



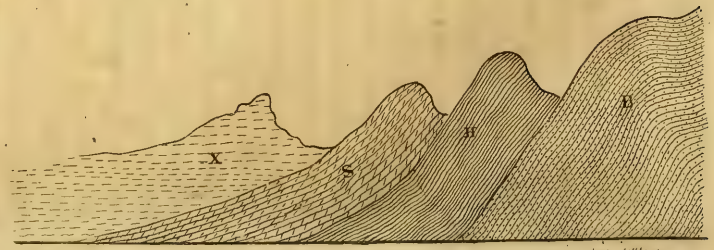
Longitudinal Section of the Hartz Mountains.



Transverse Section of the Hartz.

A. Granite.
B. Argillaceous Schist.
C. Transition limestone
D. Red Sandstone (Old)
E. Porphyry.
g. Magnesian limestone. (Zechstein)
H. Gres Bigarre (red marle) new red sandstone.
O. Gypsum.
P. Irised marles variegated marles.
I. Alluvions of the Baltic & Ocean with Granite.
S. Muschelkalk.
T. Chalk.
X. Quader sandstein.

Section of the country from Gottingen to the Hartz at Osterode.



Superposition in front of Guernerode.

Art. XIV.—*The Hartz.—Physical Geography, State of Industry, &c.; by* Thos. G. Clemson, Member of the Royal School of Mines at Paris, &c.

Perhaps no country in the world has its boundaries more naturally fixed than that mountainous district called the Hartz, (résine,*) which lies between the valleys of the Elbe and Weser.

Under the name of the Hartz is comprehended all that natural mountainous district from the centre of which rises the Brocken, and which group contains a variety of rich metallic deposits which have been worked for ages, and still continue to be the objects of successful explorations. The principal mines are those of iron, silver, lead, copper, and manganese.

This range of primitive and transition rocks rises from the centre of the vast secondary plain, bounded on the south by the primitive formations of Saxony, on the east by those of transition which extend to Dillenburg, and on the north by the vast slopes composed of the alluvion of the Baltic, and the Atlantic. Its greatest length is fourteen and a half leagues, and its breadth from Wernigerode to Illfeld is six leagues. The Hartz terminates with the commencement of the secondary plains, having on the north the villages of Goslar, Ocker, Neustadt, Ilsenburg, Blankenburg, &c. and on the south Stolberg, Ellrich, and Osterode.

The mountains forming this group are not celebrated for their height, the Brocken being the most elevated, (three thousand five hundred feet,) known as the site of the exploits of the imaginary Faust, and justly celebrated for the magnificent, and extensive view enjoyed from its summit extending on the north beyond the Elbe.

Nothing can be more characteristic and melancholy, than the aspect of those sad dreary plains which occupy the middle elevation of this range; they are singularly contrasted with its beautiful and picturesque valleys. That upon which Clausthal and Zellerfeld are built may be taken as an example; it is covered with a meagre swarth, scarce sufficing the few cows that supply these places with milk; for the other provisions of life the inhabitants are forced to have recourse

* From the resinous trees which there abound.

to the lower and more prolific surrounding country. The earth beneath appears to have grown rich at the expense of its surface; the Creator banishing all other sources of happiness and wealth, has apparently placed every thing in subordination to the mines, as if they alone were sufficient for the wants of man. The aspect of the country is sterile; the potatoe appears to be the only vegetable which this ungrateful climate fosters. The clouds, which, hurried on by the winds, are here constantly passing, render these plains disagreeable and unwholesome. The sun did not once appear through the dense mist that lowered over and about Clausthal, during the eighteen days that we spent there. The temperature is that of the lower countries during the winter.

The fir, the oak, the birch, the beech, and the yoke elm are the principal trees that cover the declivities of the highlands, which form the barriers against the torrent as it roars or meanders below. Of these, the fir is much the most frequent, and it forms the covering of those points where all other vegetation has ceased to appear; its dark foliage, joined with a clouded heaven, gives a sombre appearance to the distant valleys, presenting an *ensemble* truly sublime. Many of the valleys are rendered more beautiful by one or more artificial dams, (Bergwerksteiche.) They amount in all to thirty, and are used or kept in reserve as a power for working the mines, and for metallurgical operations; when the same valley contains several, the most elevated throws its waters immediately into the second, and the second into the third, thus forming a series of lakes and cascades. They give a very picturesque effect as they recede before the eye. That termed Oderteich situated to the west of the Brocken, and over which the road passes from Clausthal to Braunlage is very large. The principal valleys which adorn this range are those of Lautenthal, Ocker, Ilsenburg, the Rosstrapp, Magdesprung, Illfeld, Hertzberg, &c. That termed Magdesprung, contains the baths called Alexisbad, appertaining to the prince of Anhalt. This valley is naturally very beautiful, and has been embellished in the vicinity of the baths by walks, and elegant summer houses perched upon the heights around; thus offering to the invalid a variety of healthy and charming promenades. These baths are cold and much frequented during the summer season. The Hartz possesses no water-falls of note. Some of the torrents are visited by the traveller; that in the valley of Ilsenberg is remarkable for its rapidity, which arises from its proximity to the Brocken. Ockerthal is a very romantic valley situ-

ated near the village of the same name, which is never neglected by the German traveller, being the traditionary spot frequented by the fabulous Der Freyshutz. The curious who visit the Hartz, generally ascend the Brocken to enjoy the beauties of a setting and rising sun. The mountain as well as the inn which is constructed on the peak, appertains to the count of Wernigerode, to whom a list of the names, profession, &c. of those who may have passed the night there, is daily sent, bearing such remarks, complaints, et cetera, as those who attach their name to it may deem proper to make. A view from the summit of this mountain is as essential to the geologist as it is gratifying to the lover of nature, inasmuch as this is the only point from which a correct idea of the disposition of this interesting group can be attained.

Hartz.

The Hanoverian Hartz is divided into sixteen mining arrondissements or districts, (Bergwerkzuge ;) six of these are in active operation. A number of the villages are distinguished by the enjoyment of certain privileges, and are termed mine cities, (Bergstadt ;) they generally owe their origin to the exploration of a vein. Thus the mines near Clausthal and Zellerfeld were opened in the year 1600, and the above places were then founded. The veins at Andreasberg were discovered in 1520, and the cities founded the following year. They are the following, Clausthal, Zellerfeld, Wilderman, Grund, Lautenthal, Andreasberg, and Altenau. The mines and works are under the direction of a council which holds its meetings at Clausthal, where there is a school of mines possessing an extensive mineralogical cabinet, and a remarkably fine collection of models of the different machines used in the working of mines. Those minerals found in the mines, and possessing a certain intrinsic value, are sent to the school where they are taxed, and exhibited for sale.

The administration of the mines is worthy of the highest praise ; the different situations are accorded only to those persons who have proved their capability, by long and particular practice, seconded by theoretical information respecting their occupation. Each individual has his immediate calling, and gives himself entirely to the acquisition of that kind of knowledge which his department demands. Thus there are special engineers for the iron works, for

those of lead, for the machines, &c. Honesty and civility characterise those employed, and there is scarcely a workman who if questioned concerning any thing that regards his duty will not answer with promptitude and precision.

The population of the Hartz may be estimated at 55,000 souls composed entirely of persons directly or indirectly employed in the mines; the children are employed in packing and washing the ore, for which they are compensated. In those cities termed Bergstadts no person is permitted to settle without previously proving his mining capacity.

Considering the natural situation of this district, a temperate climate could not be expected; it is cold and wet during the winter, the thermometer frequently descends to —32° and never rises above 30° during the summer. Thus the inhabitants, with little interruption, keep a fire in their respective appartments during the whole year.

The mines then are the only primitive sources of industry in the Hartz, and there is not an individual who is not dependent more or less upon them. Thus a state of society is presented, differing in this respect from that of any other part of the world. The forests are subservient to the wants of the mines, or to subsequent operations, and the administration being a distinct one, consults the wants of these establishments, before granting to individuals the use of combustibles.

Geology.

We have already given the outlines of the primitive formation which abruptly disappears under the superior rocks already mentioned, evidently confirming the opinion of the posterior elevation of this group. The superior stratified rocks surrounding the primitive formations of the Hartz mountains are the red sandstone with its porphyry, magnesian limestone (zechstein) gypsum, muschelkalk, a horizontal limestone having an analogy to chalk, and a sandstone of recent formation (quadersandstein). The theoretical profile of the cropping out of the different strata from Gottingen to Osterode will give a correct idea of their relative superpositions. The other figures representing the Hartz longitudinally, and transversely, will enable the reader to fix in his mind the disposition of this interesting group.

Granite.

This rock makes its appearance at two distinct and isolated points, as may be seen in the profile. They are situated in the western part of the range, and being the most elevated points, occasion the rapid descent, already remarked upon in speaking of the torrents. This rock as it appears at the Brocken and the Rostrapp respectively, differs essentially in the state of aggregation, and consequently in physical aspect. Felspar is the principal constituent of the granite of the former, and those points which have been long exposed to the air, are of easy decomposition, giving a rounded, graceful form to the summit of this mountain, resembling that of mount Jefferson one of the peaks of the White Mountains in New Hampshire. This granite is of a reddish hue and often so resembles sienite as to deceive the observer. The crystals of tourmaline found here are well terminated but of small dimensions. The Rosstrapp is by far the most romantic spot in the Hartz, differing from the Brocken, from which it is separated by the argillaceous schist and transition limestone. Quartz forms the most abundant ingredient of this granite; unsusceptible of decomposition, its primitive rough exterior has resisted the inroads usually caused by the dilapidations of time, presenting its natural form, giving a harshness to the environs equalling the granite scenery of Switzerland. An isolated rock forms the limits of the granite formation, it is situated in the valley of Isenthal and has received the name of Iselstein; this rock is of granite and of large dimensions possessing a singular and remarkable peculiarity, that of magnetic polarity, the cause is inherent in the mass; the fragments do not alter the course of the needle.

The granite of the Rosstrapp contains irregular veins of greenstone, which appears to be of a posterior formation; the point of contact of these two rocks is compact, whereas the mass is of a strong crystalline structure; this effect might have been produced by the melted greenstone filling the crevices of the granite not yet solidified or the greenstone might owe its formation to the absence of alkali, which might have been replaced by magnesia at the moment of formation; like circumstances having existed, it would be natural to suppose, that the passage between the two rocks would be insensible. It contains nodules of quartz, and occasionally garnets; amphibole becoming abundant the rock becomes very crystalline; sometimes it contains crystals of felspar and becomes porphyritic. The

granite of the Hartz does not contain a single metallic deposit, differing in this respect from the primitive formations of Saxony; all the metallic treasures there existing in the gneiss.

Argillaceous Schist.

This is the most interesting and by much the most predominant rock in the Hartz; it is always found inclined upon the granite, which it covers, and may be considered as the continuation of the great formation seen in the country, lying between the Rhine and Marburg covered in the interval by the secondary beds of the new red sandstone; muschelkalk, and the variegated marles (marnes irisées). It passes often into graywacke and contains the following subordinate rocks:—a kind of transition greenstone, aluminous schist, argillaceous schist worked near Gozlar. Siliceous schist (Kiesel shiefer) near Altenau and a whitish compact sandstone, found upon the western inclination of the Buchberg. A considerable number of the iron ores are found in the transition limestone; with this exception the rest of the mines of silver, lead, copper, &c. are found in the argillaceous schist.

Transition limestone.

This rock is found principally between the two elevated points of granite, from which it is separated by the argillaceous schist, forming a plain upon which the valleys of Elbingerode and Rubeland are built. This rock becomes interesting in the environs of the latter of these two villages, where a bed of marble capable of receiving a fine polish, is now wrought; at the same spot powerful beds of greenstone are intercalated having a schistose structure appearing to be talcose and containing small nodules of limestone. It is in this formation and in the vicinity of Rubeland that the celebrated caverns containing fossil bones are found. There are two of considerable celebrity near the termination of the valley of Lauterberg, which however exist in another formation—that of zechstein. The iron mines found in the vicinity of Elbingerode are extremely interesting; there being more than sixteen in active operation, from which the greater part of the furnaces in the Hartz receive a portion of their ores.

Secondary formations.

We have already given an idea of the general disposition of these formations as they surround the primitive Hartz. The oldest of these rocks is the red sandstone with its porphyry which are seen in the south east extremity of the range. The porphyry terminates at Halle where it is intercepted by the alluvion of the Baltic, and of the ocean; rolled masses of granite continue to be found, until they eventually disappear under the waters of the sea.

The porphyry has its principal extent from South Neustadt to Illfeld, forming the mountains of Metzberg and the romantic valley of Barre; at this point it becomes particularly interesting, by the existence of the amygdaloids and the magnificent veins of the peroxide of manganese which it contains. The analogy that exists between the amygdaloids of this locality and those of Galgenberg at Oberstein near the Rhine is very remarkable, as also to some of the specimens lately shown me from Nova Scotia by Mr. Jackson. This locality differs from that of Oberstein inasmuch as the agates found here are rare, and cannot vie in beauty with those of Oberstein, whence after being manufactured into vases, seals, ornaments and instruments of various shapes they are sent to all parts of the world.

The red sandstone is covered by the zechstein formation rendered so very interesting by its bituminous marles, containing argentiferous pyrites, which is extensively explored near Mansfeld. This formation is constantly associated with gypsum throughout the range, which appears to be intermediate between the zechstein and the new red sandstone.

The gypsum is wrought at Blankenburg in the eastern part of the Hartz, but on a much larger scale at Osterode where it forms a range of hills running parallel with the Hartz, commencing a little to the south of this village. The zechstein contains two caverns of considerable extent, situated in the valley of Lauterberg near Scharzfeld. The new red sandstone covers the zechstein, extending to the south west as far as Cassel. This formation is not seen on the north of the mountains. The superpositions becoming more and more recent as they leave at a distance the ancient rocks of the Rhine, and Saxony which are the true bases of this secondary formation, in the center of which the Hartz is an isolated rock which has but slightly interrupted the general disposition of these vast plains.

From what has been said the reader will perceive that the eruption or elevation of this group, took place near the limits of the new

red sandstone and muschelkalk. Then it is not surprising to find this limestone inclined upon the eastern and western declivities of the highlands; the relations between the secondary and transition formations are seen to the greatest advantage on the eastern side of the Hartz, between Balenstadt and Blankenburg. The observer placed upon an elevation facing the east, is convinced of the posterior elevation of the Hartz, and for a moment thinks himself present at the epoch of this mighty catastrophe. The red sandstone is seen reposing upon the argillaceous schist, over the older secondary beds; above lies the muschelkalk which is covered by a kind of sandstone, (quadersandstein) which appeared to be of tertiary formation; thus forming a triple range of hills encircling the chain, as may be seen in the plate representing the superposition of the strata before Guernerode.

Minerals found in the Hartz.

Galena, argentiferous, crystallized, compact.
id. antimonial.
Blende, crystallized, compact.
Gray copper.
Silver, antimonial.
id. antimonial and sulphuretted.
id. arsenical.
Arsenic, native.
Seleniuret of lead.
id. of copper.
id. of silver.
id. of palladium.
Native gold.
Carbonate of lime, ferruginous.
id. ferruginous and manganesian.
Quartz agate.
Arsenical sulphuret of nickel, new variety.
Gypsum.
Sulphate of barytes.
Stilbite.
Harmotome.
Fluate of lime.
Copper pyrites.
Oxide of manganese, octahedral, prismatic.
Diallage, schiller spar.
Carbonate of lime, different forms finely crystallized.
Apophyllite.
Tourmaline, terminated.
Datholite.
Oxides of iron, red and gray.
Hæmatites, brown and red.
Carbonate of iron.
Bournonite.

Zincenite	Sulphur	22,58
	Antimony	44,39
	Lead	31,84
	Copper	0,42
		99,23.

Federerz	Sulphur	19,72
	Antimony	31,04
	Lead	48,87
	Iron	1,30
	Zinc	0,08
		99,01.

The above two substances having been lately analyzed, we have thought that this addition could not but be interesting.

Mines.

The silver mines are generally found in the western part of the range supplying the works that are constructed in their immediate vicinity for the treatment of the ore. The principal are those existing near Goslar, Clausthal, Lautenthal, and Andreasberg. The most remarkable of these is the vein which extends from Wilderman to Clausthal, traversing the city of Zellerfeld, a distance of about three miles. This vein, as are the others, is divided into a certain number of parts, termed concessions, by planes dissecting the vein perpendicularly. These concessions are let out and generally wrought by companies. Each mine has thus a distinct administration, all operations being practiced within certain limits subordinate to the decrees of the general Council of Mines which hold their settings at Clausthal; general utility being their primary consideration. The shafts Caroline, Dorothea, Duc Wilhelm, Rozenlof, &c. are sunk upon the above remarkable vein. There are several other veins in the environs, of Clausthal, but of minor importance. A less considerable one traverses the city of Clausthal in a north westerly direction. That situated near Altenau is now almost exhausted, notwithstanding the mine Juliane Sophie is actively explored. Near the village of Wilderman, there are veins upon which the mines of Lautenthal gluck, Boxwise, Regenbirge, and Joachim are constructed. The ores from these mines are smelted at Lautenthal. The ores extracted from the above mines are argentiferous Galena and copper pyrites. The copper pyrites are more abundant in those mines situated near Wilderman than in any of those mentioned. The general direction of these veins, is from N. W. to S. E., having an inclination of near 80° towards the S. W. and occasionally an extraordinary thickness, as is the case in the mine Dorothea which we visited, and where the ore is irregularly disseminated in the space of upwards of one hundred and eighty feet, causing the present irregular method of mining, there observed. The ores from the environs of Clausthal contain from one ounce to four ounces of silver per quintal.

The objects of the different explorations at Andreasberg differ entirely from those already mentioned, in the nature of the ores, in the richness of those that are similar, and in the manner in which they are found. There exists as great a difference between the ores found at Andreasberg and those of Clausthal, as there is between the physical geography of the country around these respective places. An-

dreasberg is situated on the side of a mountain of so great an inclination, as scarce to admit of the passing of carriages in certain parts of the town. The environs are very uneven, so much so that the roads which lead to the town ascend the mountains in zig zag. This city was founded in 1521. The constructions are principally of wood. The veins here are numerous and are not celebrated so much for their length, as for their extreme richness. They vary in breadth from fifteen to twenty three inches, differing in this respect from those at Clausthal. It appears that the ores increase in richness in proportion as they decend. A remarkable instance of this fact exists in the celebrated mine Samson, which is incomparably the deepest shaft in the Hartz; the lowest gallery being 50 feet below the surface of the Baltic, and 333 lachters, about 2229 feet below the surface of the earth. The descent into these mines is practiced altogether by means of ladders; one half of the main extracting pit being separated into distances of about 25 feet by means of platforms, thus rendering the fatigue more supportable and the descent less dangerous. The vein upon which the Samson is constructed, is limited on the N. W. by the the vein termed Neufang, limiting in its turn the vein Gnade-Gottes on the S. W. A remarkable fact, here observed, is that the riches of the vein are not increased at the point of junction of two veins; on the contrary the crossing vein always becomes barren beyond the joining point. After the two mines already mentioned, the most celebrated are those of Andreaskreutz, Clausfrederick, &c. having a mean direction from N. W. to S. E., occasionally crossing each other at different and appreciable angles. These mines are worked by the waters of the dam Oderteich, which are brought by the canal Rehbergergraben. Many of the ores here extracted are celebrated in science, and form distinct mineralogical species; among them may be distinguished, red silver (sulphuret,) antimonial silver, the antimonial sulphuret of silver and arsenical silver giving to the schlich an extraordinary richness. An experiment has been lately made, upon the results of which has been founded a new method of treating these minerals; in one single melting one thousand one hundred and eighty one marks of silver were extracted from fourteen quintals of schlich. In this experiment, the above mentioned minerals were alone treated. The argentiferous galena (which is much richer than that found at Clausthal) was thrown aside not being sufficiently rich. The principal gangues found with these minerals are carbonate of lime, which prevails, notwithstanding we observed that quartz formed the principal part of that found in the bottom of the Samson. Notice should be taken of

the fine harmotome, stilbite, and mesotype, and particularly of the beautiful carbonate of lime, specimens of which from this locality are seen adorning the mineralogical cabinets throughout the continent. The forms which appeared the most abundant, were regular hexagonal prisms with perfect bases, the acute metastatique, the cubo rhomboedron, &c. Of the ores galena is the most abundant, but it does not produce by any means the greater portion of silver; fine specimens of native arsenic, argentiferous gray copper, copper pyrites, &c. are found.

The Ramelsberg is an elevation of about one thousand two hundred and thirty feet above the plane upon which Goslar is situated. This mountain, which bears the same name as the mine, forms a part of and limits the argillaceous slate on this side of the range, passing often into graywacke. This rock has a mean inclination of near 46°, like that of the metallic deposit, which has been successfully wrought since the year 968.

The cropping out of this immense bed is seen about half way up the mountain, where it has but little capacity, but it increases as it descends, having a thickness at the bottom of upwards of one hundred and eighty feet. Near the center, the depot is separated and forms two beds; the inferior has the least capacity and is nearly exhausted. The greatest capacity of this deposit exists at the point of separation. The mass is abruptly terminated with an inclined plane, forming an angle of 45°, with an horizontal line drawn from the direction of the base. Disseminated masses of the gangue become frequent; and, what is remarkable, the richness of the ore diminishes as these masses of rock become more abundant, all these appearances coinciding to announce the approaching dissolution of a source of wealth, on which the inhabitants depend for their existence; notwithstanding, an immense portion of ore still exists, awaiting extraction. The ores here found are compactly mixed. They may be separated into three kinds; 1st, that in which galena and blende form the principal part; 2d, iron and copper pyrites; 3d, the ore left by the ancients, which for a length of time was covered with water, and is now extracted and washed for the sulphates of iron and copper. Some of the galleries contain stalactites of the sulphate of iron and copper, formed by the slow oozing of water through the above heaps; we were struck with the admirable effect produced by the reflective light of our lamps; giving a mellow blue tinge to the surrounding objects, scarcely capable of being described. We did not observe that any means were employed for collecting the copper of cementa-

tion, for the waters coming from these particular galleries evidently contain a portion of the two sulphates; that of copper might be decomposed by iron and collected, as is practiced elsewhere with so much profit.

On account of the nature of the ore, which is compact and excessively hard, the system of extraction here employed differs from that practiced in any other part of the Hartz, and perhaps in the world. To give an idea of the obstacles with which the miners employed at the Ramelsberg have to contend, we join the following extract of a process verbal, drawn up in 1808, to prove the impossibility of applying the ordinary mode of extraction, (by means of powder.) The ore in which this essay was commenced, was compact, very hard, and chiefly composed of iron and copper pyrites. "A workman was employed eighty eight hours in boring a hole four inches deep; during this time two hundred and one boring augers were rehardened, twenty six were remounted with steel, and one hundred and twenty six were entirely destroyed." The method of working actually employed is by fire, which has a powerful disaggregating action upon the ore. The heat is applied by means of a pile of fir wood, built up from the floor to the ceiling of the gallery; this wood is of easy ignition and like all resinous woods, produces a great deal of flame, sometime after the fire is put to the pile a continual cracking is heard, produced by the disaggregation, and falling of the detached ore. Without doubt this separation is due chiefly to the expansive force of those matters capable of taking a gaseous form as arsenic, sulphur, water, &c. After the temperature has sufficiently fallen, the workmen arrive and separate a great deal of ore attacked, but not detached by the fire. Notwithstanding the great action of heat the use of powder cannot be thus entirely replaced, for there is a certain part of the gallery, the inferior angle, upon which the flame has little or no action, and the employment of powder is of absolute necessity which enormously increases the expenses of extraction. All expenses paid for the extraction of forty tons of ore by the method of blasting, cost from thirty eight to forty Prussian dollars, and the same quantity by means of fire twelve dollars and a half. The Prussian dollar is equal to seventy five cents. Thus if by any means the combustibles in the Hartz should be destroyed or become so scarce as not to permit of being thus employed, either some other mode of extraction sufficiently economical should be substituted, or the ruinous necessity of abandoning the Ramelsberg will be a necessary consequence. The quantity of ore extracted per week is about forty tons.

The mines of lead, silver and copper, that are found in the principality of Anhalt, are similar to those of the Hanoverian Hartz. The treatment differs but little, the mattes (coarse metal or sub sulphurets) are melted in the same furnace with the schlich (washed ore). The copper mattes instead of being heated for copper, are roasted and washed for the sulphate. There is a vein of hematite situated near Harzgerode, celebrated for the quantites of seleniuret of lead that have been found there. Of late it has become very rare, so much so that no traces of this mineral are now to be seen, and specimens of that which has already been extracted are procured with difficulty, on account of some of the ore having contained a few atoms of native gold, which (lest the world should forget the existence of this, the smallest of principalities, counting in all one hundred and twenty thousand souls, and actually governed by three princes) has been carefully collected, and struck off into medals, bearing the inscription "*Ex Auro Anhaltino.*" The selenium has heretofore been extracted from the ore by the method given by Mr. Mitcherlich; we had the pleasure of seeing twenty two lbs. of this rare substance, shown us at Victor Frederick's silber Hutté where it is sold at the rate of eighty francs the ounce.

The argentiferous copper pyrites is found disseminated in the bituminous schist (or bituminous mergel-schiefer) of the zechstein formation, in which it exists in very small proportions, not visible to the eye. Its mean contents are from two to three per cent.; still there are but few ores that are treated with greater advantage. The marne* as extracted from the mines, is of a black color, which is owing to the bitumen dividing easily into layers, between which are very often found fine impressions of fish, generally in very distorted positions; this schist occasionally contains small portions of galena, and is principally extracted in the environs of Eisleben and Mansfeld.

Silver works.

Under this appellation are included all those vast establishments where the silver, lead and copper ores are treated; they are generally located in the vicinity of the mines, which exist principally in the western part of the range. The traveller is struck with the immensity of the scale upon which they are constructed; his near approach to the works is announced by the deadly appearance of the

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* Marle, referring we suppose, to the bituminous marle slate.—*Ed.*

earth, which is entirely void of vegetation for some distance around, having been destroyed by the deleterious vapors. Those establishments that we have hitherto visited, appertaining to private individuals, more or less circumscribed in their capacity by pecuniary considerations, scarce suffice to give an idea of these justly termed royal works. The hills of scoria collected around the immense black constructions, glaring with the light of the furnaces, the whole half disappearing amid the volumes of dense vapors which cloud the heavens in the vicinity, produce an aspect really imposing. The traveller's first visit into the interior of the works, gives him but a confused idea of the great regularity and remarkable simplicity that constantly reign throughout the series of multiplied operations which on the first superficial glance appears to be so complicated.

The quantities and low price of lead, thrown into circulation by the mining operations in Spain, has occasioned a great deal of uneasiness throughout the Hartz. The greatest possible activity is now every where displayed, and the quantity of precious metal produced has become the principal object of the treatment, and thus assays have been made with a view of introducing more economy, into their operations; the result of these as will be seen, was very happy, so much so, that new and more advantageous methods have been substituted in place of those heretofore employed, which might be chosen as land marks, to show the advancement of Science. We have entered into certain details respecting the ancient methods, to make more evident the cause and successful result of these extremely interesting assays which we copied ourselves from the note books of the different works.

Franckinscharner Hutté, is the name of the great central works, situated about one mile and a half from Clausthal, in a valley which receives the waters of several mines. Upon this small stream, there are twenty one bocards for the mechanical preparation of the ore treated at the works. Franckenscharner Hutté gives employment to one hundred and sixty workmen, who together with those engaged in the mines that supply the works, amount to upwards of three thousand hands. The mettallurgic works, properly speaking, appertain to the crown of England; the bocards to private individuals, and the mines are generally explored by companies; the ore extracted is purchased by government, and the value of each schlich (washed ore) is verified by three assays, one made on the part of the mines, a second for the works, and a third as the verification of the other two. These assays have another very important advantage, that of procuring

sufficient data, from which, the different mixtures employed in smelting are formed. For the last century the melting of the schlich has been performed in high furnaces (20 feet); and the method consists in desulphurating the galena by means of granulated iron,—the ore not having undergone any preceding chemical preparation. Such other additions are made to the galena and iron, so as to insure a perfect fusion, calculated after the result of the assay.

The following is the composition of one of the mixtures or smelting heaps for the schlich.

38 quintals of Schlich, (ore washed).
5½ " " Granulated iron.
48 " " Scoria.
2 " " Abstrichs, with a portion of litharge taken from that which is produced during the latter part of a cupellation, containing from one half to three fourths loths of silver per quintal.

Charcoal is the only combustible employed in this operation, for frequent assays have proved that a portion of schlich is invariably lodged in the pore of the coke, if this combustible be employed, thus preventing the action of the reducing agents, and causing a loss in the metal which not observed when charcoal is employed. Three times the quantity of mixture, as given above, (one rost) may be passed in a single furnace per day; when the furnace is in good order two hundred cubic feet of charcoal are consumed in melting one rost, or the above quantity. The metal is drawn off at intervals of from one hour to one and a half according to the energy of the furnace. The product of this operation is a certain quantity of lead containing silver, and a great deal of matte, (coarse metal, sub sulphurets,) scoria, &c. besides a deposit found in the series of canals that form the cheminees.

The lead is cupelled for silver, giving litharge, abstrichs, &c.

The working of the mattes comprehends the following series of operations.

1. The first matte is roasted three or four times; these roastings last three or four weeks, after which they are smelted in a furnace differing from the first in dimensions, and in the manner of charging. The smelting mixture is thus composed.

32 quintals of roasted mattes.
30 " " scoria containing .10 of lead,
5 " " cupelling bottoms, ashes containing litharge, silver, &c.
3 " " scoria produced by the reducing of the oxide of lead.
1 " " granulated iron.

The combustible employed in this operation is coke; a like mixture produces from fourteen to fifteen quintals of lead, containing silver, and from ten to twelve quintals of mattes.

2. The matte produced by the last operation is roasted three times; each roasting lasts from eight to ten days, after which, it is smelted with the same mixture, and in the same furnace as the preceding, producing from ten to twelve quintals of lead (containing silver), and from seven to eight quintals of mattes.

3. Matte roasted three times and passed in the same furnace.

4. Matte, after roasting, is smelted with a different mixture composed of

32 centnars of roasted mattes.
20 quints. of scoria.
1 quint. of granulated iron.

The products of a like operation for twenty four hours are thirty four quints. of lead,—thirty quintals of a fifth matte, which now takes the name of copper matte (Kupferstein),—which is treated precisely as the last, giving a certain quantity of lead, and from forty five to fifty quintals of a sixth matte, containing all the copper of the ore, which is sent to Altenau to be purified. Here finishes the series of operations practised at Franckenscharner Hutté.

Production of Franckenscharner Hutté, in 1827.—21,942 marks, 5 loths of silver not refined, and 20,264 marks, 2 loths refined; 14,655 quintals of litharge for commerce; 294,880 quintals of litharge to be reduced; 26,968 quintals of lead.

Production and consumption in 1828.—2,560½ roests of schlich were smelted, (which contained after the assays 19,348 marks, 1½ loths of silver, and 48,013 quintals of lead) besides 54,257 quintals of mattes, which gave 25,687 quintals of lead to be cupelled, 52,731 quintals of lead mattes, and 904 quintals of copper mattes. The lead by cupellation yielded 21,343 marks of silver not refined or 19,740 of refined silver; litharge for commerce 14,900 quintals, litharge to be reduced 45,230 quintals.

Consumption.—64,922 maas of charcoal 25,322 balgen of coke. 2,213 maas of Pine buds, 5,948⅚ schlorhs of fagots, 2,561 matters of fir wood consumed in roasting the mattes. 12,990 quintals of iron 3,607 postes of 12 hours each; 9,990 postes of 24 hours each. Total expense of the works 103,619 Prussian dollars 9 silver groschens 3½ fenings.

An experiment for the substitution of a new method of smelting the mattes.

	Mixtures (Lits de fusion.)									Production.			Contents in metal by assays.					Cupellation of lead.						
													Lead.		Silver.							Fagots.	
	Mattes.	Lime.	Iron.	Cupel bottoms.	Abstrichs.	Scoria.	Postes of 12 h'rs.	Charcoal.	Coke.	Lead.	Mattes.	Scoria.	Mattes.	Scoria.	Lead.	Mattes.	Scora.	Silver.	Silver.	Litharge.	Abstrichs.	Rich Litharge.	Shocks.	Fagots.
	qts.	qts.	qts.	qts.	qts.	qts.		Maars.	Balgen.	qts.	qts.	qts.	lbs. per qtl.		loths.	loths.	loths.	marks.	loths.	qts.	qts.	qts.		
Iron,	700	- -	22	88	22	528	17	123	444	242	108	832	38	7	- -	$1\frac{7}{8}$	$\frac{5}{8}$	78	3	153	23	9	17	20
Lime,	700	55	- -	88	22	532	17	127	444	258	137	834	30	6	- -	$1\frac{3}{4}$	$\frac{1}{4}$	80	10	165	27	10	17	45

The operation in which the iron was employed, gave 80 centners of cupel bottoms: the lime, 78. Thus the results are decidedly in favor of the lime, which, by being employed instead of the iron, would give a saving of 2510 quintals of iron per annum.

Method now employed for the fusion of the mattes with limestone.—We have seen that the compound of sulphur and lead existing in the mattes after roasting has been heretofore decomposed by granulated iron. The above experiment having been crowned with success we add the composition of the smelting beds, and the result from the first to the ninth of Oct. 1929.

32 quintals of roasted mattes,
4 " " Cupel bottoms,
2 " " Abstrichs,
2 " " Limestone,
$27\frac{1}{2}$ " " Scoria from the smelting of schlich.

During this time twenty three mixtures, composed as above, were smelted, producing two hundred and sixty six quintals of lead, containing silver (Plomb d'œuvre) and one hundred and sixty nine quintals of mattes. Consumption, six hundred and ten balgen of coke.

The schlich has been heretofore smelted in high furnaces, with charcoal, and iron employed as the only agent of reduction. Coke is not used. The pores of this combustible lodge a portion of the ore, thus preventing the action of the reducing agent, and proportionally increasing the quantity of metal in the scoria.

Essays have been undertaken with the intention of substituting the methods so advantageously employed in the treatment of the mattes, thus replacing the granulated iron by limestone in the fusion of the ore. These attempts were not as successful as the former. The fusion was unequal, and the scoria rich in lead, apparently owing to the infusibility of the sulphuret of calcium.

Mr. Ethropel, sub director of the silver works, thought that the lime could have no action upon the galena, and that in the course of smelting the mattes, the lime only acted upon the sulphuret of lead through the intermedium of sulphuret of iron, or the iron liberated by the presence of lime, acts upon the galena. Mr. Albert on the contrary justly held, that lime had a direct action upon sulphuret of lead as already proved both by the experiments of Mr. Berthier and also by the assays differing in the proportions of limestone and iron employed; two distinct assays were made with limestone alone, the results of which prove the fact beyond a doubt.

To throw aside any causes of error that might arise from the fineness of the schlich and porosity of the coke, the graupen alone was employed; graupen signifies small pieces of ore obtained by an instrument now very much used in the Hartz, termed setzfass. This instrument is filled with small pieces of ore and gangue and is thus agitated in water by any mechanical power. The gangue or lighter pieces remain at the surface. The graupen or rich ore is found at the bottom.

The following table contains the results of the essays, made upon this product, in the furnace termed Manche, at Lautenthal.

	Mixtures.							Products.				These products contain per quintal.							Combustible.	
													Mattes.		Scoria.		Deposits.			
	Time.	Graupen.	Scoria.	Scoria.	Cupel bottoms.	Iron.	Lime-stone.	Lead.	Mattes.	Scoria.	Deponts	Lead, Silver.	Lead.	Silver.	Lead.	Silver.	Lead.	Silver.	Coke.	Charcoal.
	hours.	qts.	qts.	qts.	qts.	qts.	qts.	qts.	qts.	qts.	qts.	lots.	lbs.	lots.	lbs.	lots.	lbs.	lots.	balgen	maas.
1st essay.	20	39	21	24	6	4	0	20	22	52	3	4	35	$1\frac{3}{4}$	4	..	16	$\frac{1}{4}$	52	8
2d "	20	39	21	24	6	3	2	19	23	55	$3\frac{1}{2}$	4	46	2	3	traces.	16	$\frac{1}{4}$	66	8
3d "	19	39	21	24	6	2	4	16	25	54	4	4	49	2	4	$\frac{1}{16}$	16	$\frac{1}{4}$	62	8
4th "	21	39	21	24	6	1	6	15	30	55	3	$3\frac{3}{4}$	52	2	3	..	16	$\frac{1}{4}$	50	8
5th "	20	39	21	24	6	0	8	14	28	60	$4\frac{1}{2}$	6	65	$2\frac{3}{4}$	6	$\frac{1}{16}$	16	$\frac{1}{4}$	54	8
6th "	23	39	21	30	6	0	0	9	30	67	4	4	74	$2\frac{3}{4}$	4	$\frac{1}{16}$	16	$\frac{1}{4}$	78	8

Lautenthal.

These works are vast, and possess the materials for the treatment of copper pyrites, and the copper mattes (Kupferstein). They are situated in the picturesque valley of Lautenthal, near the mines and village of Wilderman distant about three leagues from Clausthal. The magnificent reservoirs of the Boxwise are seen about half the distance between the two places.

These are the only works now existing in the Hanoverian Hartz where copper pyrites are directly treated; formerly there were works to this effect near Lauterberg, but the vein has long since been exhausted. These works contain four high furnaces for the fusion of schlich; three cupelling furnaces, a certain number of furnaces for the treatment of mattes and reduction of litharge, and one chimneé for the purification of the Kupferstein, &c.

The mines of Lautenthal Gluck, Boxwise, Regenbirge and Joachim supply the ore. The copper pyrites is now more abundant here than near Clausthal and is separated by picking, furnishing near forty thousand quintals of galena containing a little copper, and near one hundred quintals of copper pyrites (Kupferkies); in general one quintal of schlich yields seventy pounds of lead and two and three fourths loths of silver. The operations for the extraction of lead and silver are precisely similar to those followed at Clausthal.

Heretofore ashes have been used in forming the bottom of the cupelling furnace, one of the principal inconveniences of which, is the great quantities of cupelling bottoms (ashes containing silver and lead) to be afterwards treated; another is the price of cinders. Experiments were made at Lautenthal for the purpose of employing marne instead of ashes; the first costing but ten bons groschen the ton, and ashes from thirteen to sixteen. To prevent the bottom of the reverberatory furnace, employed in cupelling, from being destroyed by the oxide of lead, it is necessary to give to the ashes which cover the bottom which is of brick, a thickness superior to that part impregnated with the oxide of lead. The inferior part of this bed when made of ashes, and after calcination is superior in quality to that of the same substance not having sustained the action of fire. The contrary is found to take place with marne. This fact announces a change in the mode of operation. Formerly that part of the calcined ashes not impregnated with lead, was placed in the middle of the furnace for the support of the silver. The inferior part of the bottom of the cupelling furnace is now made of ashes, which remain immoveable, covered as usual with a bed of marne. A certain portion of calcined marne may be added to that now calcined without sensibly altering the results. The limits of the mixture are indicated in the table.

Comparative Essays for cupellation, made at Lautenthal, 7th October, 1829.

Substances employed.	Rich Lead.	Substances (ashes, marne) forming the Cupel bottoms.		Running of the Litharge.	Silver obtained, not refined.		Poor Litharge.	Rich Litharge.	Cupel bottoms.	Abstrichs.			Contents of the Cupel bottoms.	
													Lead.	Silver.
	quints.	tons.	himpten.	hours.	marks.	lots.	qts.	qts.	qts.	qts.	tons.	himpten.	lbs.	lots.
With ashes.	112	9	2	16	21	1	69	3	31	8	4	2	89	$\frac{1}{4}$
With marne.	112	9	2	15	22	9	87	1	14	9	5	3	80	$\frac{1}{4}$
With ashes.	112	9	1	14	21	13	69	2	31	11	4	2	90	$\frac{1}{4}$
With marne. Calcined *tons.* $1\frac{3}{4}$ / Not calcined *tons.* $5\frac{1}{2}$	112	9	1	14	23	6	86	1	14	11	5	2	78	$\frac{1}{4}$

Essays made at Lautenthal for the Fusion of Mattes with Limestone.

Agents employed for the reduction of the sulphuret of lead.	*Mixtures.*							*Product.*			*These products contain per quintal.*					*Combustible.*		
	Time.	Matts.	Scoria.	Cupel bottoms.	Litharge.	Lime-stone.	Iron.	Lead.	Mattes.	Scoria.	Lead. Silver.	Mattes. Lead.	Mattes. Silver.	Scoria. Lead.	Scoria. Silver.	Coke.	Charcoal.	Pine apples.
	hours.	qts.	qts.	qts.	qts.	qts.	qts.	qts	qts.	qts.	lots.	lbs.	lots.	lbs.	lots.	balgen.	maas.	maas.
Iron,	316	3360	3780	630	315	00	96	1528	1005	4416	3-3$\frac{1}{4}$	52-55	1$\frac{3}{4}$-2	6-11	..	1705	50	156
Limestone,	316	3360	3780	630	315	192	00	1472	1107	4608	3	50-53	1$\frac{3}{4}$-2$\frac{1}{4}$	6-14	..	1695	50	144

These results prove that the iron acts rather more energetically than the limestone. The quantity of lead containing silver is less, and the matte rather more; however this difference is more than counterbalanced by the use of limestone.

The central works at Ocker. Frau Marien Sarger Hutté.

These works are situated at the mouth of the interesting valley of Ocker on the horizontal limestone of tertiary formation. They present themselves in a very imposing manner in consequence of the clouds of smoke that cover the little village, and the immense heaps of black scoria, which form the banks of the torrent that takes its rise near Altenau. This stream contains rolled scoria coming from the ancient workings near that place; they are collected and re-smelted with advantage, and contain upwards of fifteen per hundred of metal.

The series of operations here practised is among the most complicated in the world, caused by the nature of the ore from the Ramelsberg. The operations are separated into two vast series founded upon the treatment of the two distinct classes of ore. The one is composed principally of copper and iron pyrites, the other of galena and blende; both contain gold, silver, zinc, arsenic and antimony; the gold is in such small quantities as never to be detected in the assays undertaken for the purpose; it is concentrated in the silver from which it is separated.

Production of these works in 1828.—Six hundred and seventy one marks, nine lots of silver not refined (from lead). Three hundred and forty marks, thirteen lots (from copper). Two hundred and seventy quintals of litharge for commerce. One thousand six hundred and ninety one quintals, forty and a half pounds of lead from the reduction of litharge. Sixteen quintals thirty two pounds of zinc (from lead). Three quintals and ninety pounds (from copper). Three thousand one hundred and eighty one quintals and seventy nine pounds of copper.

Herzog Julius Hutté.

These works are large and are situated at the foot of the chain, about two leagues from Goslar. They treat the ores of lead from the Ramelsberg.

Production in 1828.

Silver, not refined,	2,218	marks	11 lots.
Litharge, for commerce,	3,780	quintals.	
Lead, " "	2,918	"	85 lbs.
Zinc, " "	34	"	75 "
Abstrichs, " "	189	"	65 "

The department for gold is carried on at the Frau Marien Hutté.

Frau Sophien Hutté.

These works are situated about half way between Herzog Hutté and Lautenthal. Production in 1828.

Silver, not refined,	1,024 marks	9 lots.
Litharge, for commerce,	1,554 quintals.	
Lead,	1,421 "	80 lbs.
Zinc,	10 "	41 "

The Lead, Silver and Copper works at Andreasberg.

The different furnaces, buildings, &c. composing this establishment, have of late been newly constructed. The arrangement observed is at once simple and convenient, presenting one of the finest models of metallurgical architecture that we have seen. They are situated in a valley about a mile distant from Andreasberg. The arsenical vapors emitted, are sensible for some distance around, so much so as to occasion nausea at the distance of an hundred yards: what is remarkable, the workmen here employed, suffer less than those at Frankencharner Hutté; this may be owing to the difference of activity in the cupelling furnaces of the two places. At the latter of these places, there are three or four furnaces in constant operation, and the vapors disseminated in the atmosphere, injure the health and distort the limbs of those employed at this particular operation, to a horrid degree.

The ores that are treated are those mentioned in speaking of the mines. There are subordinate officers situated in different parts of the mine, whose immediate business it is to put aside those portions of ore, as red silver, &c. extracted in pieces large enough to admit of their being broken and picked, which is the only preparation that these ores undergo previous to their fusion. The galena and the finer part of the ore is washed as at Clausthal, and elsewhere.

Product and consumption in 1828.—During this year there were smelted, 399½ rosts of schlich, containing after essays 7,528 marks ¾ loths of silver, and 4,783 qts. 5 lbs. of lead which produced 17,910 qts. of lead, containing silver which yielded 7,670 marks, 7 loths of unrefined silver, and 7,074 marks, 7 lots of fine silver, 5,654 qts. of litharge, 6,588 qts. of cupel bottoms and 150 qts. of fine copper. The greater portion of the litharge was reduced.

Total sum of the expenses in 1828, is equal to 27,401 prussian dollars, 20 groschens, 5 pfenings.

Result of an extremely rich essay made in 1829. The great richness of the ores worked at Andreasberg, had long since given rise to a like idea, which was as often rejected. The richness of the mixture might occasion a loss of precious metal by volatilization, as also by the scoria, and the mattes. The essay was performed, the schlich was smelted without the formation of mattes and without much loss. The mixture contained about 80 marks of silver per quintal. The ores employed in this melting were the red silver, and antimonial silver; the argentiferous galena was considered too poor for treatment.

The fusion was made in any ordinary high furnace and the mixture composed as follows.

			Marks.	Loths of silver.
14	quintals	78 lbs. of schlich containing	1181	$1\frac{1}{2}$
7	"	26 " " another schlich, "	366	$12\frac{3}{4}$
24	"	of mattes of a common operation, "	4	$2\frac{1}{2}$
220	"	" litharge, containing	1	$11\frac{1}{2}$
48	"	" scoria of a 2d matte,	0	3
100	"	" scoria of a 2d matte (diff. opera.)	0	$6\frac{1}{2}$
12	"	" Iron,	——	——
		Quantity of silver contained in the bed,	1554	5

The products of this fusion were

180 quintals of rich lead,
2 " mattes, (a small quantity comparatively speaking.)
262 " scoria,
50 " Ofenback, (or bricks containing metal from the furnace.)

A small quantity of an alloy resembling cast iron, probably a mixture of antimony and arseniuret of iron, weighing twenty seven pounds, containing from two to three loths of silver.

The consumption of this fusion was

100 maars of charcoal, costing 3 thalers 8 bons groshen the 10 maars.
10 postes of 12 hours at 11 bons groshens the poste.
10 postes at 7 bons groshens,
30 hands at 4 to $5\frac{1}{2}$ groshens.

The 180 quintals of lead were cupelled at two different operations producing 1284 marks $10\frac{1}{2}$ loths of refined silver.

90 quintals of litharge,
76 " cupel bottoms,
41 " abstrichs,
20 " rich litharge.

Consuming 13 shlocks of fagots; 60 himpten of ashes; 48 hours.

The result of this assay gave general satisfaction, and is now followed. The extremely small quantity of mattes produced, and the short space of time employed in extracting the precious metal are sufficient advantages to insure its constant use.

The works situated at Altenau.

The village of Altenau is about four miles from Clausthal. The works are situated at a little distance from the village at the head of Ocker vale. The principal foundery has nearly the capacity of that of Andreasberg, and is like it, of new construction. The heaps of scoria collected in the vicinity, give an idea of the activity that prevails in the interior. The machines are moved by the waters of the valley, which are employed farther on at Ocker.

The product of these works surpasses that of the mines of Franckencharner. The annual product in silver equals 17600 marks, and the business afford besides all the necessaries for the purification of Kupferstein (Shwarts Kupfer). The mines in the environs of Clausthal chiefly the Dorothea and the Caroline, supply these works with ore.

Quantity and richness of the Schlich worked at Altenau.

		Silver.		*Lead.*	
Names of the mines.	Number of Roests.	Marks.	Loths.	Quintals.	Pounds.
Dorothea,	590½	3698	13½	11310	32
Caroline,	179	1482	9½	3810	108
Kranich,	20	138	2¼	242	49
English Trene,	10½	61	1½	139	44
Herzog Wilhelm,	4¼	24	9½	54	95
Kœnig Wilhelm,	13	74	6	177	12
Bergmanstroit,	166¾	1145	3¼	3390	82
St. Margarette,	20	292	9½	458	8
Anna Eleonore,	11 11/12	88	14¼	157	88
Nuen Rosenhoff,	64	245	7	1009	54
Alten Segen,	84	352	3½	1452	12
Kœnigen Charlotte,	4				
Knapf Aften,	6	391	6¾	1015	17
Knapf Halden,	15	96	2½	260	62

The last two quantities of schlich are not the product of any mine in particular. They come from the washing of the poor sands collected from that of the other ores. These poor sands being put aside in the summer, are washed during the winter, and the profits go to the invalid miners.

Mean Products of the Silver Works in the Hartz, from 1806 *to* 1826.

	PRODUCT.								CONSUMPTION.						
Names of the Works.	Gold.	Silver.	Copper	Litharge.	Lead.	Lead, from abstrichs.	Zinc.	Sulphur.	Iron.	Ashes.	Charcoal.	Coke.	Wood.	Fagots.	Pine apples.
	marks.	marks.	qts.	qts.	qts.	qts.	qts.	qts.	qts.	tons.	maas.	balgen.	maas.	schocks.	maas.
Frankincharner Hutté.	..	18,000	..	14,000	26,000	..	..	..	13,300	5,000	84,000	30,000	3,400	5,100	4,000
Altenau.	..	17,600	100	6,000	13,000	..	..	..	5,000	2,200	40,000	18,700	2,500	2,400	1,600
Andreasberg.	..	14,000	135	..	3,100	..	..	..	900	1,800	37,000	..	1,900	1,600	2,000
Lautenthal.	..	6,000	185	1,000	14,000	..	..	..	5,500	2,500	42,000	20,000	2,000	2,000	2,000
Julius Hutté.	..	2,700	..	3,200	3,000	200	30	..	..	..	..	..	..	..	..
Sophien Hutté.	..	1,200	..	1,300	2,000	120	11	..	..	..	..	..	..	..	..
Ocker Hutté.	..	1,000	2,500	400	1,800	56	52	..	..	..	..	..	..	..	..
Gold Foundery.	11	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Manufactory of Sulphur.	..	..	..	..	..	..	..	1,804	..	..	..	..	..	..	..
Sum.	11	69,500	2,920	25,900	71,900	376	93	1,804							

In addition to the above works, this district abounds with furnaces and forges, for the treatment and purification of iron. There is a large manufactory of Brass at Ocker, belonging to the Duke of Brunswick. Near Neustadt there is a small establishment for the evaporation of a water containing salt which is extracted from a well, hard by. The construction and order observed in these works is really very beautiful. The Hartz contain two manufactories of ozar of Cobalt; the mineral here treated is brought from the Rhine. The smoking sulphuric acid termed Nordhausen is manufactured from iron pyrites at three different places, namely, Nordhausen, Braunlage and Tanne. The method given by Mr. Hauseman in his travels in Scandinavia, for the collecting of sulphur from iron pyrites is practised at Victor Frederic's silver works in the department of Anhalt. The white lead works, situated at Osterode, are very large, and this is the only establishment that we were not permitted to visit during our stay in the Hartz. Finally, there is a manufactory of arms at Hertzberg which enjoys a very high reputation throughout Germany. We cannot quit this interesting country, without commending the cordiality of the inhabitants towards strangers. The people are simple, frank and unwearied in their services, and the word *Gluckauf* (the miners' salutation) is the only passport necessary in journeying through this land of science, in which the means of instruction are very great.

Art. XV.—*Remarks upon the present mode of conducting Land Surveys in the United States; by* Edwin F. Johnson.

The continent of America, previously to its discovery and settlement by the Europeans, was in the possession of a people, uncivilized in their character, wandering in their habits, and depending for a subsistence upon such precarious means as the lakes and streams or forest, from day to day afforded. Fixed habitations and separate individual proprietorships in land were consequently unknown, and territorial divisions were not acknowledged, except in respect to the hunting grounds of the several tribes, which were defined by such boundaries as nature had formed in the various ranges of hills, or courses of the different streams which in every direction spread over and diversified the general face of the country.

When therefore the emigrants from the east seated themselves on these shores, a new order of things was established. Bringing with them as they did, the habits, customs, &c. of the civilized nations of Europe, they found it necessary to institute a system of separate and distinct individual titles in land. The first settlements were made principally upon the rich bottoms contiguous to the mouths of the larger rivers, and the portions taken by the settlers were generally selected according to the kind and quality of the soil and timber, without regard to any regular or systematic mode of allotment.

In many instances by a mutual understanding, tracts of a given width, measured along the margin of the bay or river, were assigned to each occupant, extending back to an indefinite distance into the interior; the positions of the dividing lines being a matter of compromise or arbitration, in which the parties were aided by such imperfect instruments as were used in guiding their vessels across the Atlantic. In process of time the settlements thus formed, were viewed by the mother country as likely to constitute important appendages to her dominions. This consideration, in connection perhaps in some instances with the solicitations of the settlers themselves, induced her to extend over them her government and laws.

From this period the right of soil may be considered as exercised in full force by the crown, except in particular cases where respect was paid to the long enjoyed possessions of the settlers. The lands were no longer taken up at the option of individuals, in such places and to such an extent as they thought proper, but were the subject

of bargain and sale either with the crown, or with those who had been regularly invested with a title.

Speculations in this, as in most of the business concerns of life, were entered into for the purpose of gain. Companies of individuals were formed to whom, for a trifling consideration, grants or letters patent of large tracts in particular situations were issued, and these were divided into smaller parcels, and retailed out at an advance upon the original purchase.

In this state of things is discovered the commencement of the present system of land surveying as practiced in the United States. The extreme cheapness of lands, called for the most economical and expeditious mode of executing the surveys; and their abundance rendered the proprietors less scrupulous as to the accuracy with which the measurements were effected. They consequently availed themselves of the most convenient means, viz. of the compass or circumferentor for the measurement of angles, and the chain of Gunter for the measurement of lines. The services of men properly skilled in the art of surveying were seldom to be obtained, and reliance was necessarially placed upon many whose knowledge of the subject was extremely imperfect. The instruments likewise with which they were provided were often of an inferior kind, and as the surveys were not generally made in conformity with any established and properly arranged system, but according to the option or to suit the wishes or interests of the individuals concerned, great irregularity and much confusion and discrepancy were the consequence.

In process of time however, improvements were gradually introduced into this department. These may be briefly stated to consist in the increased facilities afforded for the acquisition of knowledge upon the subject, by the publication of treatises of a more practical and scientific character, and the introduction and use of improved instruments, with a more enlarged and liberal view of the importance of adhering to a more regular and systematic mode of proceeding than had previously been adopted.

The influence of the general spread of intelligence as evidenced in the progress towards a higher degree of perfection in our civil Institutions, and in the various branches of the sciences and the arts, has not, it is to be regretted, been as conspicuous in this department as in most others. It is not easy to account for this, for the subject is certainly one of great intrinsic importance, and the demand for

skill and experience in relation to it, has undoubtedly been greater in this country than in almost any other. The improvements which have resulted have been confined to, or their benefits principally experienced by the new States. In the order and regularity of their surveys—the judicious arrangement and location of the building plots and streets in their villages—the preservation for future reference of plans correctly executed, on which are distinctly traced on a scale sufficiently large, the form and dimensions of each separate right, those states are far before the older and more settled portions of the country.

The introduction of the system first instituted in the western part of New York and since, with some modifications, adopted and pursued by the general government in the surveys of the public lands, is probably one of the most striking examples of the improvements to which we allude. By this system the townships and subdivisions of townships or sections and quarter sections, are disposed in a square form, the lines of each corresponding in direction with the cardinal points of the horizon;—an arrangement from which no deviation is permitted except when necessarily interrupted by a state or Indian boundary, or by navigable waters.

The preceding may be considered as exhibiting the progress and amount of improvement in the department of surveying in this country for the long period of about two centuries which has elapsed since its first settlement. There is, probably, no art or profession in which native talent and skill has displayed itself to less advantage. The circumstance of our continuing in the same beaten track with our predecessors, may, perhaps, be attributed to a want of consciousness on the part of the public, of the importance of the subject, or to the fact that the public attention has been engrossed by other matters of seemingly greater moment, or more probably to both combined.

That there is ample room for improvement there can be no doubt, and the time I trust is not far distant when the requisite measures will be taken for effecting a thorough and judicious reorganization of the mode of conducting the land surveys in every state in the Union. Perhaps I cannot better illustrate the importance of such a change than by exposing some of the more exceptionable parts of the present system.

Among the most prominent of the existing evils may be mentioned that of the general incompetency of surveyors both as it regards the requisite preliminary qualifications, and a proper practical knowledge

of their profession. It is an opinion too prevalent with many that the surveyor's art, as it is termed, is of easy acquisition, and may be attained by an individual of moderate capacity, and very moderate acquirements, in a short space of time. This impression is assuredly a very erroneous one, and for the general good ought to be corrected. It has been and is now often the case that young men who are but imperfectly acquainted with the principles of common arithmetic, and who by the cursory perusal of some of the ordinary treatises on surveying, have acquired but a very superficial knowledge of the subject, are permitted to practice under sanction of such rules as our state Legislatures have thought proper to prescribe. The result of this incompetency is, that in some instances calculations of measurement, instead of being made by a rigid and correct trigonometrical or arithmetical process, are effected by such uncertain means as the accuracy of scales, or of measurements made with dividers upon a miniature draught or plan may afford. It is very frequently the case likewise that many in making computations, are restricted as it were to a mechanical use of the rules by which they arrive at results, and as they have never been thoroughly inducted into the principles on which those rules are based, are often at a loss or led into error when a case occurs out of the ordinary course, or of a character different from what they have been accustomed to meet with in practice. It would not be difficult to specify numerous instances of these disqualifications, but I shall content myself at present with mentioning only one. In a certain township in New England where the lots are laid out in the form of oblique angled parallelograms, the resident surveyor for a long time followed the method of casting or computing them as though they were squares or rectangles, and he continued in this practice until he was undeceived by an individual who was not a surveyor, but who had common discrimination enough to detect the error. The history of surveys in different parts of the country is replete with examples of this character, but the one I have adduced will suffice to illustrate the nature and extent of the class of evils to which it refers, and I will proceed in the next place to notice some other evils which result not so much from incapacity in the surveyors themselves as from imperfections in their instruments.

In comparing the instruments of different surveyors, particularly their circumferentors, it is seldom that any two of them are found to be constructed alike. The artist employed in their fabrication almost invariably deviates in some respect from others he has seen, to favor

some conceit of his own, or to suit his peculiar taste and sense of propriety, but their improvements as they are termed, are generally nothing more than alterations; and the reason is plain, for those who make them have commonly little theoretical and no practical knowledge of the subject. As instances of the imperfections alluded to, the following may be mentioned. The radius of graduation is frequently too small, thereby diminishing the effect of the force by which the needle is brought to and retained in the direction of the magnetic meridian, and likewise rendering the divisions upon the circle smaller than is proper for the correct reading and determination of the fractional parts. The needles are not always finely pointed and their extremes brought close enough to the edge of the graduated circle.

Their shape instead of being the best, viz. that of exposing the greatest surface, is often the reverse. They are likewise often inaccurately poised, the point of support not being sufficiently near the center of gravity of the needle, and in a line with its extremes. The bearing point at the center of the needle is frequently not formed of the best material as it regards resistance from friction, and the instrument is but seldom provided with verniers for obtaining fractions of of degrees, or with spirit levels for regulating the perpendicularity of the *sights*, circumstances of great importance as it respects the accuracy of an observation. In the use likewise of this instrument there are many sources of error which are not always understood and of course not guarded against. The needle, from disuse or other causes, not unfrequently loses much of its power, and becomes less susceptible of the magnetic influence, from the resistance of a free and easy motion occasioned by the accumulation of rust or other obstruction at its point of support. Precautions are not always taken to ascertain whether the needle, in making an observation, is influenced by local attractions of a magnetic character, and whether it is not likewise influenced by causes confined to the instrument itself. I allude now to the effect of the electrical fluid which sometimes collects on the glass of the instrument, a circumstance which probably more than any other, operates in diverting the needle from its proper direction.

In addition to the preceding may be mentioned the want of skill in the mode of effecting the adjustments, and the reliance which is too often placed upon the trunks and tops of trees, &c. as objects of sight in the tracing of lines, together with the errors of the chain,

resulting from the wear and consequent stretching of its parts, the ignorance and carelessness of chainmen and from other causes which it is not important at present to detail.

The disagreements which have been known to exist in measurements made by different surveyors may be attributed to a part or all of the causes above recited. The influence of those causes is indeed often so great that the "balance of errors" constitutes one of the most important items in a surveyor's estimate of the result of his measurement.

The preceding remarks upon instruments for the mensuration of angles have reference exclusively to the circumferentor, and they are thus directed under the conviction that for a length of time to come, instruments of that description must continue to be used as a principal dependence in the tracing of lines in all surveys in this country. Indeed, the possession of a good theodolite or other similar instrument by any of our surveyors would in the present state of things prove almost an anomaly, and, if I mistake not, the day has not long passed, if indeed it has quite gone by, when some of our surveyor's general were unprovided by their respective states with any instruments of an order superior to the common circumferentor or compass.

The little expense and study demanded in preparing an individual for this department has caused it to be filled by many who are quite incompetent to the correct discharge of its duties, and of course has depreciated it very much in the estimation of the public. So great is the number now engaged in this profession, compared with the business to be done that few are willing professedly to qualify themselves and to incur the expense of providing the requisite instruments, and perhaps an instance can scarcely be found, especially in the older states, of an individual deriving a respectable and competent support from surveying business alone. Under these circumstances it cannot be expected, that the profession in comparison with others should take a very high rank, or one corresponding at all to its importance.

I do not presume to say that there are not many of the profession who deservedly sustain a higher character than I have described. The remarks which I have made will however I think apply generally and with justice.

A state of things like this must obviously be attended with many consequences unfavorable to the interests of the community generally. The various litigations and disputes about boundaries, which our courts of justice are constantly called upon to decide, are most of

them either directly or indirectly the result of the present loose and imperfect method of conducting land surveys. This evil is not however, it must be acknowledged, confined exclusively to the surveyors. Many of our lawyers, who are intrusted with the drafting of instruments of conveyance, are often deficient in the knowledge requisite to render their descriptions of land correct and to place them beyond the possibility of a misconstruction. The only instruction which this class of men usually receive on this important subject is the scanty amount ingrafted into a collegiate course, embracing perhaps a knowledge of the method of instituting a few proportions and resolving a few problems in plane trigonometry, but which can by no means be regarded as embracing a knowledge of surveying, in its more enlarged and appropriate sense. It is a mistaken idea, that an individual who can count the divisions on a graduated circle and repeat a few propositions in geometry, is competent to the correct tracing of lines or the performance of the various duties of a surveyor. The directive property of the magnetic nedle is truly productive of the greatest service to mankind, but like many other agents in nature it loses much of its value in unskilful hands, and a similar liability to error is incurred in other matters relating to the subject by those who are not thoroughly and scientifically versed in the practice of the profession.

I have already alluded to the method of surveying the public lands as exhibiting the least exceptionable and most agreeable feature in the present system. In the planning of that method, much judgment and foresight were displayed, but while the design is justly to be approved and admired, the means for carrying it into effect are liable to most if not all the objections which have been stated with respect to the present mode of surveying; and it is greatly to be feared that the beauty of the whole will be impaired and the intentions of its projectors in a great design defeated, unless measures are soon taken to correct some of the existing evils.

With a view of remedying many of the defects and obviating many of the difficulties arising out of the present condition of things, the following is presented as a general outline of the manner of organizing a system adapted to each state in the Union.

1st. There shall be in each state a Surveyor General.

2d. This officer to be appointed by the Governor and senate, or governor and council, as the case may be, and to hold his office for the term of (say) six years at least.

3d. He shall be allowed a stated salary, and this salary to be ample, but not extravagant.

4th. It shall be his duty to superintend generally the surveys of the state. He shall be provided with instruments suitable to the purpose, and constructed on the most approved plan; he shall be competent to determine with the greatest practicable degree of accuracy the latitude and longitude of places; he shall establish meridians in each county of the state; he shall likewise possess a general knowledge of most of the natural sciences, particularly Geology, Mineralogy,and Botany,* and shall receive and retain such plans and reports of surveys, as may be delivered into his possession. He shall also execute in person the tracing and location of all state and county lines, and of all lines of communication uniting in their range two or more counties, and shall attend to the compilation of such plans and reports of surveys as may be made in the several counties, and shall form them as often as necessary into one general and accurate map, to be constantly preserved in some convenient place for reference. It shall be his duty likewise to examine at stated times such instruments as are used by his assistants or deputies, &c., and ascertain if they are in perfect order, and of a kind corresponding to the most approved standard.

5th. One assistant or Deputy surveyor to be appointed for each county. Each candidate for this station of Deputy surveyor to be recommended or nominated by the surveyor general, and his appointment to be sanctioned by the governor and senate, or governor and council. The office to be held for the term of (say) four or six years. The deputies to be provided by the state with such instruments as the surveyor general shall approve and to receive a certain amount per diem for their services, to be paid by the person or persons under whose order or request the survey shall be made.

6th. The Deputy Surveyors to be called upon, and it shall be their duty to attend to the making of surveys, estimates, plans and descriptions in writing of all lands the titles of which shall be transferred or in any wise changed, and likewise for all lands placed under lease, the terms of which either by express limitation or by possible contingencies may exceed twelve or fifteen years, and these conditions to be made as important to the validity of any such transfer, change or lease as any other condition required in law.

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* If qualified to make observations also in Meteorology and Agriculture, it will greatly increase his usefulness.

7th. The Deputies shall at stated times compare their instruments with the meridians established in their respective counties, and with the standards of measure with which they may be furnished, and in their surveys in addition to the usual remarks they are to be particular in noting as accurately as possible, the exact position of every object of interest in a Geological, Mineralogical, Botanical or Agricultural point of view that may fall within the lines or tract to be surveyed, and they shall furthermore make out a plan and report of the same, a copy of which shall be forwarded to the Surveyor General and the expense of the same defrayed by the state. In every plan or description of a survey the bearings of the several lines are to be given with reference to the established meridian, and on some part of the plan shall be noted the variation of the magnetic needle, as last observed, with the amount and mode of applying the proper correction to adapt it, if possible, to the precise time of executing the survey.

Were a system of the character above described to be instituted in each state in the Union, the public would derive from it an incalculable benefit. The lines of surveys would be correctly established, the limits of each separate tract of land would be defined with an accuracy and certainty which no other method could ensure; most of the numerous vexations and litigations arising out of disputed boundaries would be avoided, and society would be saved the unpleasant feelings and personal strifes, and heartburnings which such disputes invariably occasion, and (what is of equal if not greater importance,) the resources of the country would be developed to an extent which it is not easy to calculate. Within a very few years as correct a topographical knowledge of the whole country would be obtained as is now possessed of any of the older countries of Europe, and the precise localities of the various valuable Mineralogical, Botanical, and other natural productions would be given with a degree of precision of which no other country can boast, and surveying, as a most useful and necessary branch of the sciences and the arts, would rise to the rank to which, from its importance, it is justly entitled.

As landed property is constantly increasing in value, greater accuracy will be required in the execution of the surveys, and we cannot in consequence too soon commence upon an improved system, for the longer the change is delayed, the more firmly shall we be established in error, and a reformation if effected will bring with it but a portion of its benefits.

The necessity for the establishment of a more perfect and well regulated system is indeed greater in this country than in almost any other. In Europe and particularly in England the right of soil is generally possessed in extensive tracts by the Crown and Nobility, or by the more wealthy of the population. And as the subdivisions are leased, perfect accuracy in the surveys is not as requisite as in this country, where the fee simple of each farm or plantation is generally vested in distinct and independant occupants or proprietors, thus rendering it an object of importance to be able correctly to define the precise extent of ground embraced in each title or conveyance.

It is to be hoped that the public generally and those who have an influence in the management of their affairs will realize the importance of this subject, and that they will take it seriously into consideration with a view of bringing about such a change as cannot but redound greatly to the general good.

It has hitherto been too much the case that our Legislators instead of proposing and adopting those measures by which many of the disputes and difficulties which affect and vex society, might be avoided, have contented themselves with merely prescribing the means of equitably settling such disputes when they do occur. Certainly the first object is of equal importance with the second and in most cases the advantages on the side of the prevention of an evil are decidedly superior to those of the best remedy which can be proposed.

It is one of the leading and justly admired features of our civil institutions, that property as well as life and liberty is secured and equally so to all, and the individual who conforms to the just requisitions of the law, exercises in every other respect as uncontrolled a sway over the possessions which his skill and industry have acquired to him, as the most unrestricted monarch over his regal domains. That this invaluable right may be exercised in every instance without danger of interference or collision, the artificial lines by which the right of property in land is distinguished, should be distinctly and correctly drawn.

In the sacred volume it is written, "Cursed is he that removeth his neighbor's land mark, and all the people shall say amen." Surely if a malicious attempt to remove or to obscure the monuments which designate the limits of a possession is deserving of so severe a malediction, it must be an object of no inconsiderable importance to be able to establish those monuments with precision, and with a proper regard to the rights of all concerned, and likewise to

provide the means of restoring them with accuracy, if by any accidental circumstance they shall be lost or destroyed.

Middletown, Conn. September 5, 1830.

Art. XVI.—*Remarks upon the salt formation of Salina, N. Y. and other places; by* Joshua Forman, Esq.

TO THE EDITOR.

Dear Sir,—Since I saw you in January last, I have spent some days in the neighborhood of the Ondago salt springs, and from the facts there learned from intelligent gentlemen as well as from my own previous acquaintance with the subject, there can be no doubt that the principal grounds on which the new theory of the formation of salt in the salt formation of the canal district, advanced by Mr. Eaton in his survey of the district bordering on the canal are founded in a mistake as to the existing facts. He seems to suppose the salt formation one of no great depth, which had been bored through without finding rock salt, and from that circumstance, and its not appearing where the rock was cut by streams and gullies, he infers that there are no beds of salt in it; and he seems to fortify himself in this opinion by the fact, that gypsum, one of the principal accompanying minerals, does not exist in that rock: page 112, he says "Mr. Byington found the water grew stronger at every foot he bored in the rock at Salina, but after he had bored *through* the rock he found that he gained nothing by boring eight feet further in the conglomerate rock beneath it;"* and page 113, "gypsum is never associated with the salt formation in the canal district." The village of Salina is built on a red crumbling rock answering in all respects to the red marle formation of Conybeare and Phillips, in which the Cheshire salt mines are situated. This falls rapidly to a marsh extending to the lake. In this marsh Mr. Byington bored through indurated clay gravel to a bed of washed gravel partially cemented together, called by Mr. Eaton conglome-

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* In later publications of Mr. Eaton, he has announced the discovery of pseudomorphous crystals, in lias and in the rock containing the salt springs of the west; which, he believes, were made by real crystals of common salt. And, in a paper read before the Albany Institute, he considers the salt-bearing rock as of such a thickness, that Mr. Byington's borings could not have reached its lower surface by two or three hundred feet. Therefore he leaves the question respecting the existence of rock-salt, undecided in his own mind.—*Ed.*

rate rock: it is not yet known to what depth this bed of gravel extends. Mr. Ford, in behalf of the state, sunk a well into it forty feet from the surface, about thirty rods southerly of the place where Mr. Byington bored; and Mr. Stephen Smith has lately bored into this bed of gravel to one hundred and forty feet below the surface, finding the strength of the water increase until it exceeds the old springs at Salina. But that this layer of gravel overlies the salt formation even under the marsh, is rendered most probable from the circumstance that some persons have lately bored at Grun Point, west of Salina, near the lake, (as I was informed by W. Kirkpatrick, Esq. superintendent of salt springs,) upwards of two hundred feet in the red rock from the surface, near the level of the lake, and have found the salt water increasing in strength as they penetrated downwards; from which it is clearly inferable, that the salt formation is one of considerable thickness, which has not been bored through by Mr. Byington, or any one in that vicinity; and that the source of the salt water lies too deep to furnish any chance of its being exposed by the cuts made in the rock by streams in that level country, constituting the basin in which salt springs are found along the line of the canal. As to the existence of gypsum associated with the salt formation, it is a matter of general notoriety, that lumps of it are thrown up in digging salt springs and wells in the village; and in sinking a well at Montezuma, before that survey was made, one hundred and sixteen feet deep, beautiful specimens of gypsum were found nearly transparent, several of which I had for years on my mantel-piece as curiosities. This well was sunk through a succession of layers of sand, gravel, and indurated clay, comparing almost exactly with those described in Holland's survey of Cheshire, as overlying the salt rock of theirs; from which, and the perfect coincidence not only of the formation but the gypsum associated, there was a full general conviction, that the salt formations of the canal district also contained beds of salt rock; and which still continue undiminished where the facts are known; but as the statements made in that work may lead those at a distance to entertain false notions of the character of this salt formation, and false theories of the formation of salt, I think it for the interest of science that the facts of the case should be known, and the friends of science cautioned to investigate more carefully the grounds upon which a theory is based at variance with the known facts in other parts of the world where salt springs are found.

As the salt rock is found in beds, it is not to be supposed that it exists as a layer in this formation, extending under the whole surface, and it may not be found exactly under the springs where they rise. The salt water may pass from between the layers of the salt formation where it falls off towards the lake and its base, covered with the layer of washed gravel, indurated clay, and marsh mud, and rise in that to the surface; while the beds of salt may lie under the plain back of the village, as there are many places where the earth has fallen away, forming sinks and indicating currents of running water below, carrying away the substratum, the salt rock as has been supposed, in its passage from the hills to where it rises in springs at the edge of the marsh. And this is rendered more probable from the fact, that on cutting a large vein, oak leaves, acorns, dried mandrakes and pieces of wood have been found in digging salt many feet below the surface of the marsh, in such preservation and freshness, as to furnish strong grounds to believe they passed through some subterranean passage, from the plain to the interior of the marsh where they were found.

New York, March 9th, 1830.

Art. XVII.—*Safety of Steam Boats.*—Editor.

The painful interest connected with this subject continues to receive occasional augmentation from the recurrence of fatal accidents. We refer our readers to some remarks in the beginning of the first article of the present number, and although they were written several months since, they are (if correct and judicious) more seasonable now than ever. The late fatal catastrophe on board the United States, Steam Boat of New Haven, is in some respects, more interesting to the community than any one that has preceded it. This increased importance grows out of the fact that we are here deprived of the usual extenuations by which we hope to persuade ourselves that the accidents are fortuitous, and that they may not occur again. On board the United States there was a full supply of water, and the flue was not unduly heated; there was no improper pressure, and less than had been usually employed; the part of the boiler that failed was new; the commander was a veteran, distinguished for his experience, skill and vigilance, and his people were sober and faithful; still an explosion occurred which de-

stroyed one sixth of all the persons on board; we cannot therefore enjoy the consolation of imputing blame, and must charge the catastrophe to causes that may and will produce the same effect again.

In other cases we hear, indeed—that in one instance, the water was deficient and the flue became red hot; in a second, that the safety valve was obstructed or over loaded; in a third, that the supply tube was choked; in a fourth, that the boiler was old and had become weak; in a fifth, that the metal, although new, was flawy; in a sixth, that they were in a strife for speed, and carried too much steam; and in a seventh, that the engineer was ignorant or intemperate, and the commander unqualified or remiss.

All these causes and others have doubtless in different cases, contributed to produce explosions; but still the painful conclusion is forced upon us, that *explosions of steam boilers are produced by the energy of the power and by the weakness of the materials.* Our efforts must therefore be directed to the controlling and regulating of the power, and to the best use of the copper and iron, of one or the other of which the boilers are always made, and to their most judicious size, form, construction and position. This subject has recently attracted the attention of the Franklin Institute in Philadelphia, and that very useful and patriotic body has published a judicious circular, calling for exact information as to the facts that may tend to illustrate the causes and to indicate the remedies for explosions by steam. They direct their inquiries particularly to

The Boiler.—Its size, form and relative thickness, the material from which it is made, (of copper or iron, &c.) if of iron, whether of foreign or American iron, especially in the boiler that exploded.

Safety Valve.—Its form, size, load in proportion to the thickness of the boiler, liability to get out of order, facility of repair, number used, location of the valve.

Supply of Water.—Mode of insuring a sufficiency, how guaged?

Arrangement of the Boilers in the Boat; which is less liable to accident?

Construction of the Boat—to avoid accidents in the boilers.

The very respectable names attached to the circular give us the best pledge, that a valuable report will, hereafter be given to the public.

In the mean time, however, other explosions will occur, and other victims will be added to the great number already immolated by these thunder strokes of a power which so often proves more than a match for human skill. There is every possible motive for increased

effort in improving the means of producing, managing and controlling steam; and with no view to diminish, but rather to quicken those efforts, we urge, that certainly for the present, and perhaps forever, the safety of the community must depend upon one of two arrangements.

1. Having two boilers* placed on the guards of the vessel over the water, and separated from the passengers, not only on the side,† *but every where*, excepting at the mouth of the furnace, by a bulwark made of timber, and sufficiently strong to resist, not only water and steam, but also the fragments that may be projected, or even the entire boiler should it be thrown from its bed.

2. By taking a passage vessel in tow, the power being generated in one vessel, and the passengers being in another.

The first arrangement would be particularly important in such waters as are occasionally rough, where towing might be inconvenient and at times impracticable, as on Long Island Sound, and the Chesapeake and the great lakes. To the second there seems no objection of any weight, upon waters protected from storms, and which are generally smooth; such as all our rivers and many of our bays, and arms of the sea. The excessive speed which is now aimed at, is of no importance; no reasonable man will be dissatisfied if, (sleeping and waking) he can go ten miles in an hour, which exceeds the rate of the swiftest mails in Europe, and is hardly surpassed by the fastest sailing ships of war. This degree of speed and probably more is attainable in tow boats, and we have thought the important suggestions of Mr. Richard Sullivan, an experienced scientific as well as practical engineer, contained in the subjoined paper, which originally appeared in the Daily Advertiser of New York, worthy of being preserved, as containing an excellent summary view of safety-barges, towed by steam boats. With him, we greatly fear that explosions will never be entirely prevented; and while several of them occur every year; while many valuable people are thus torn from life and from their friends, in a manner even more agonizing than by the casualties of war; while general anxiety pervades the community, and we *know that*, (like the Parisians of late) *we are reposing over a volcano;* no time should be lost in adopting such means of prevention or of safety, as cannot fail to be in a good degree successful, at least in preserving the lives, now so often sacrificed; and the num-

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* See page two and three of this Number for additional remarks.

† Open of course towards the water.

ber of which will be greatly augmented whenever an explosion shall happen among the congregated hundreds, who now, *tempted by a mischievous nominal fare*, crowd the decks of many of our steam boats, so that they resemble transport ships, in a time of war, more than vessels for safety and pleasure, in a period of peace. The double remedy now pointed out is worthy of the more consideration from the proprietors of steam boats, because all those now in use, (with a great addition to their accommodations as well as safety,) can be furnished with the double boilers and the protecting bulwarks, which, to afford every possible security to their people, should be adopted, even where the safety-barges are added. Then all the protection will be afforded, which the present state of our experience admits, and it will probably be sufficient, even should science and art do no more for mankind on the subject of steam; explosions will be diminished in number, because the boilers will be smaller, and more anxiously watched, and the victims, few in number, will be those who, like soldiers and sailors in time of war, encounter a known danger, and have a right to, and will obtain, a reward in some measure proportionate to the risk incurred. *The proprietors of steam boats must answer it to their country and to God, if they neglect any practicable means of defending their fellow creatures from the most awful and afflictive casuality to which the confiding traveller is exposed.* No scheme will answer which does not either remove the passengers from the danger, or remove the dreaded boiler from the crowd which surrounds it, and from the possibility of deluging men, women and children in boiling water—in boiling brine—in an atmosphere of overheated steam, or of destroying them by the fragments, or by the entire boiler, projected among their crowded ranks. *The boat which is first ascertained to afford absolute security will be a fortune to its proprietors.*

ON THE SAFETY OF STEAM BOATS.

Theodore Dwight, Esq.—Sir—Your paper, and others, having given expression to the public solicitude on occasion of the late accident on board the Marshall, in reference to the future safety of passengers, it may be presumed that any suggestions to that end will be acceptable to a community with whom the inquiry may well arise, whether there can be any sure remedy for this danger?

To mention only some of its sources will enable all to answer the question for themselves.

The engineer (commonly so called) is not perhaps the person to whose negligence these calamities are chargeable, but rather to the Fireman; who, besides throwing in the fuel, has to see, by the guage cocks, that the water is kept adequately supplied. This station is extremely arduous, and he is to an unusual degree exposed to the temptation of drinking inordinately. The boiler is usually made of large diameter, and with an inside flue, which is intended to be always covered by the water. This is not the strongest form in which a boiler can be made, but is that which takes up the least room. This flue may, not only from the inattention of the fireman, but from any accidental obstruction or disorder of the supply pump, get uncovered, or the water low, when it will become red hot, soft, flexible, thin, and weak; and as this part of the boiler is out of sight, this may happen (to a degree short of giving way) frequently in the course of a season: and although the proper quantity of water may be presently regained, still the hidden weakness thus caused remains, and may show itself fatally at some subsequent period. If it were asked, how is the thickness of a boiler in all its parts, after being some length of time in use, ascertained to be sufficient? The usual method is to strike it with a hammer, wherever accessible, trusting to the indications given by the sound of the blow. In the making of boilers, it is possible that the plates may have flaws not quite obvious enough for their rejection, and it is not uncommon for rivets to break by the expansion of the metal, if not made of very good iron. Boilers may be kept in use too long, when the business is not very profitable. It is an expensive job to displace them for repairs, and it is natural to defer it as long as may be safe. Steam boats are sometimes sold at auction, to close a concern, when although the age of the boiler may be told, its condition cannot be so easily known.

It is commonly supposed that the safety valve is an effectual safeguard; and it is so, in a well made and well managed engine. The intention of it is to allow the steam to vent itself when it gets so strong as to lift the weight hung upon the lever of the valve. But it has been known to be fatally overloaded. Besides it is not calcuated to give passage to a great and sudden increase of steam. And such sudden and great increase may happen when the flue has been long enough bare to get red hot, and water is suddenly restored in sufficient quantity to receive its accumulated heat. It is well known that water boils at 212° of Fahrenheit. But it is not so generally known that after this degree of heat, every additional 30 degrees,

doubles and redoubles the expansive force of the steam, and that it requires very much less fuel and time to produce this 30 degrees more heat, than to produce the preceding 212°.

As explosions have not been confined to high pressure engines, and as the effects have been so tremendous, it has been supposed that the red hot iron of the flue must sometimes decompose a portion of water into its constituent gases, (hydrogen and oxygen). But it does not seem to be necessary to resort to this supposition to account for the effects, if we consider the amount of the force suddenly liberated by the disruption of the boiler. It must be equal to the outward pressure on a square inch of the safety valve, perhaps never less than 20 lbs., multiplied by every square inch of the internal surface. The displacement of the boiler with such surprising violence may be accounted for from the recoil or reaction of the force from the first considerable resistence it meets with; as well as by the expansive force in the direction it takes. Thus when the Hoboken boat exploded, I am told the boiler was thrown upwards—the rupture being at the under side. That of the Helen McGregor being towards the stern, the boiler went over board through the bow of the boat. Had the forward end burst, it might have been thrown as far as the cabin. The boat may be so injured as to immediately sink—the force driving some part of the machine through the bottom or side; or the shock may start the planking. In two instances the boat has sunk. The danger of this must be greater when the boilers are below, than when on deck.

Every one will admit that it will be for the interest of owners, masters, and men, to take the utmost care. But the danger is inherent in the nature of the power, and it is greater than that from negligence. One fact alone proves this: that the safety valve has not been a sufficient protection in either of the melancholy instances of explosion that have taken place. What is the inference? It must be that the boiler, though up to that time strong, has some how become too weak to bear an expansive force below what it was intended to contain; or else that somehow that force has become suddenly so great that the safety valve cannot give vent to the steam.

If then there can be no perfect assurance of safety in steam boats, and so far as depends on fidelity and judgment, much confidence must be reposed in individual laborers, there can be no safety but in keeping out of the reach of the explosion, should it happen; but this can hardly be done, if in the same boat. My opinion, long since

formed, and the occurrence of so many accidents—the increase of travel, and the number of steam boats employed, and the circumstance of their growing old, like other machines and vessels, prompt me to remind you of your being, some years ago, on an arbitration between the late Mr. Fulton and myself, to settle the question which of us had first originated the improvement in steam navigation, of separating the load from the power—the passengers from the danger. Had the award been in his favor, this method would probably have been then carried into practice; but being in mine, the exclusive privilege granted by the state to the North River Company, prevented. Yet I have the satisfaction of knowing it had the approbation of that distinguished leader in the art of steam navigation, and I now with pleasure see it in successful use for commercial transportation on the Hudson. But the attempt to carry it into effect for passengers, made with the steam boat Commerce, two years ago, was too feeble; she having no more power than is usual in boats of her class for their own impulsion.

The original design was to appropriate and devote the *leading* boat to the power, and to employ more than is usual for one boat; ample room on board permitting this conveniently, and of using the strongest form of boiler. The *follower* is attached to the leading boat, at a suitable distance, and in a manner that allows of steady motion; and being of a light, sharp construction, with one deck, the resistance of the water and air will be but small; indeed, it is the most favorable plan for great speed. It is yoking the gigantic powers of steam to a floating car, and driving them fearlessly along the liquid plain. There is also economy in this plan of operation. Fuel is the heaviest item of expense. The use of *anthracite coal* in steam engines, is a desirable improvement in their management. Hitherto, the difficulty was in augmenting and diminishing this kind of fire at pleasure, in boats. It required a peculiar form of furnace. I mention it because it will afford a sufficient degree of protection against excessive competition, should the state of public feeling positively require, in future, this perfectly safe conveyance.

It is not probable that the memory of the late accidents will pass away, as others have, with only a transient impression of their horrors. The danger has at length come near. Every boat to and from this city bears the connexions and friends of some of us. Were it simply a question of benevolence, or of some public improvement, it would be carried by acclamation. But there is one

difficulty in the way. It is *considered a branch of business*, in which the public has no more concern than in stages. It is left to the enterprising in its line, and all trust that competition will produce perfection, as well as cheapness. And it might be left to ordinary competition, were it not a question of life. It is, in this respect, quite different from all other branches of business. It is a concern belonging to the public, as well as to the owners of the boats, and yet its defects and dangers are not of a nature to be prevented or guarded against by any law. Nothing but a determination of the community to have and sustain safe steam conveyance, will avail.

This branch of enterprise has taken the form of rivalry, in splendor and rapidity, and these admirable qualities will still command an ample share of business. But, however admirable, they do not compensate for the risk of life. Why should not the public be also entirely satisfied on this point, and have the choice, at least, of safety. This improvement remains to be made, and superadded. Knowing its practicability, and the excellent accommodation of which this method is capable, it seems incumbent, at this time, thus to bring it into view. If its suggestion meets with approbation, a company may, perhaps, be formed, with sufficient capital for two equipments, one to proceed every day from New York to Albany. The passage may in this manner be accomplished, it is thought, in ten hours.

As travel is always increasing between these cities, and as a rational preference would be given to a commodious yotte, (yatch) drawn swiftly and steadily along, there seems to be some reason to expect the concern would be profitable. But the prevailing opinion may be, that it cannot be said to be certainly an object of speculation, or a source of profit. Perhaps the undertaking must rest alone on the basis of philanthropy and public spirit. If, then, on this ground, the prevailing sentiment of the community is favorable, perhaps it will be manifested by an ample capital, subscribed in moderate sums, especially should it meet the approbation of those who assemble daily at the banks and public offices, and to administer the city government. It is a measure of self-defence.

Submitting the subject thus to you, sir, for a place in your paper, I am, very respectfully, your humble servant,

JOHN L. SULLIVAN, Civil Engineer.

Patterson, N. J. 29th April, 1830.

MISCELLANIES.

(DOMESTIC AND FOREIGN.)

1. *Travelling term of Rensselaer School, for* 1830, *with a notice of the nature of the Institution.*

Communicated by Prof. Eaton.

The Rensselaer School at Troy, in the State of New York, has now been in operation six years. It was established by the Hon. Stephen Van Rensselaer, in the year 1824, and placed under the immediate care of Professors Amos Eaton, and Lewis C. Beck. A board of Trustees, with a President, were invested with the guardianship of the School. The next year after its establishment, the Legislature of the State of New York gave it a charter of incorporation with very ample powers.

Three distinctive characteristics of the school given by its patron. Three years, and unlimited funds were allowed to Messrs. Eaton and Beck, to make the experiment.

1. The most distinctive character in the plan of the School, consists in giving the pupil the place of teacher, in all his exercises. From schools or colleges, where the highest branches are taught, to the common village schools, the teacher always improves *himself* more than he does his *pupils*. Being under the necessity of relying upon his own resources, and of making every subject his own, he becomes an adept as a matter of necessity. Taking advantage of this principle, students of Rensselaer School *learn* by giving experimental and demonstrative lectures.

2. In every branch of learning, the pupil begins with its practical application; and is introduced to a knowledge of elementary principles, from time to time, as his progress requires. After visiting a bleaching factory, he returns to the laboratory, and produces the chlorine gas and experiments upon it, until he is familiar with all the elementary principles appertaining to that curious substance. After seeing the process of tanning, he enters the laboratory with most ardent zeal for a knowledge of the principles upon which the tanner's operations depend. He can now apply the experiment for making an insoluble precipitate of tannin and animal gelatin, also the soapy compound of animal oil and an alkaline earth, &c. After seeing buhr millstones consolidated by a gypsum cement, he is anxious to try the

experiment of disengaging the water of combination in the gypsum, to observe the effect of re-absorption. By this method, a strong desire to study an elementary principle is excited, by bringing his labors to a point where he perceives the necessity of it, and its direct application to a useful purpose.

3. Corporeal exercise is not only necessary for the health of students, but for qualifying them for the business of life. When such exercises are chosen by students, they are not always judiciously selected. Such exercises as running, jumping, climbing, scuffling, and the like, are calculated to detract from that dignity of deportment and carriage, which becomes a man of science. Therefore a system of exercises is adopted at this school, which, while it improves the health, also improves the mind, and excludes those vulgarisms, which are too often rendered habitual among students. Such exercises as land-surveying, general engineering, collecting and preserving specimens in botany, mineralogy, and zoology, examining workshops and factories, watching the progress of agricultural operations, making experiments upon nutritious matters proper for vegetables, &c. are made the duties of students for a stated number of hours on each day.

These principles have now been practically applied for six years, to the full satisfaction of the patron and trustees; and numerous schools are now set up, from Canada to Georgia, as germs from this original stock.

Experience has taught that Natural History, (embracing Geology, Mineralogy, Botany and Zoology,) and Engineering, should be more practically illustrated, than can be done at one location. To obviate this difficulty, *a travelling term* has been instituted. Three tours of this kind have been taken—one of six weeks, one of five weeks, and one of eight weeks. It is now fixed at six weeks, to commence on the first Thursday after the last Wednesday in June, every year. The extra expenses having varied considerably, on account of the different views and feelings of students, all expenses (including what has been called necessary extra expenses,) are now fixed at $60. This includes all ordinary travelling expenses, board, washing, lodging, tests, instruments, &c. Also, all the excursions to Trenton Falls, Oswego, Ithaca, Niagara Falls, Eighteen mile Creek, &c. This particular account is given to aid other Institutions in making their calculations for similar tours, on Connecticut River, the Mississipppi, Ohio, &c. And it should be required, that no parent allow his son more than one dollar for his pocket.

Localities visited, and some incidents of the travelling term of 1830, *in the form of a Journal.**

Tuesday, June 22.—Visit the Magnesian rocks at Hoboken, opposite New York, and collected specimens of serpentine, hydrate of magnesia, magnesite, &c. Collected marine plants, and some marine animals.

Wednesday, 23.—Take the steam boat for Tarry-town. Visit the opposite Palisadoes in row-boats. Collected specimens of Basalt in most of its varieties—as greenstone trap, amygdaloid, and basaltic breccia (trap-tuff). Columns often twelve feet in diameter, in very regular polygons. Cross to Sing-Sing.

Thursday, 24, 33 M.†—Visit the extensive vein of copper pyrites, which is embraced in a calc-spar gangue, and walls of limestone.—Visit the State prison, which is built of the granular limestone, on which it stands. Examine both shores of the Highlands in a sail-boat, as far as the Military Academy at West Point. The rocks at both extremities of the Highlands are of gneiss and hornblende—next towards the centre, sienitic hornblende—centre ones, crystalline and slaty granite, (gneiss,) alternating with hornblende rocks.—Here we find green and white coccolite, and beautiful grains of grass green serpentine, set in tabular spar—also, resplendent hornblende, in veins traversing slaty granite, and gneissoid hornblende rocks.

Friday, 25, 54 M.—West Point. Take the steam boat for Catskill. Leave four students at Newburg, to collect the sapphire, &c. found on the back of the Highland rocks, six miles south of Newburg.

Saturday, 26, 110 M.—Visit Catskill Mountains. Ascend through the vast chasm, called Kaaterskill Clove, and return from the Mountain House down the turnpike. On the east side of the Hudson, the clay slate variety of argillite, alternating with silicious slate, is the basis rock. This passes into the wacke variety of argillite immediately on the west side of the river. The first graywacke is next in succession; then the carboniferous limerock becomes the

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* These facts are from the MS Journal of Prof. Eaton, as far West as Whitesboro; whence severe sickness compelled him to return home. The remainder is taken from the journals of the Rev. David Brown, Prof. Edgerton, Adj't Prof. Houghton, and from the journals of Messrs. Stevenson, Bement, and other students.

† M, means miles from the City of New York.

prevailing rock, and extends five or six miles, through the village of Madison. This is the same rock which embraces the Bethlehem caverns near Albany, and extends through Esopus, and along the Hudson and Delaware canal, far into Pennsylvania. It lies under the second graywacke slate, which contains the Carbondale and Lehigh anasphaltic coal, with petrifactions of glumaceous plants,* &c. It is somewhat sparry at its under side, becomes the calciferous sandstone, and finally the metalliferous limestone. At the upper surface of the latter it becomes undulated slate. This slate constitutes the basis of Catskill Mountains, and here contains anasphaltic coal in small quantities. One of the students, Mr. Stevenson, collected specimens of the coal on the Kaaterskill, four miles west of the village of Catskill, precisely at the meeting of the cherty limerock and the second graywacke slate. He was conducted to the locality by Mr. John Ashley of Catskill. On ascending the mountain, we found perpetual alternations of red sandy graywacke, (red sandstone,) gray sandy graywacke, red graywacke slate, and gray graywacke slate. The top of the mountain is every where terminated upwards with conglomerates, (wacke breccia,) being a less firm variety of the millstone grit. The red sand contains stylastrites in abundance, half a mile south of the Mountain House, on Little Lake. Very few imbedded or disseminated minerals are found in Catskill Mountains. Quartz crystals, sometimes containing liquid drops, are found in the calciferous sandrock, at the base of the Mountain; particularly near the village of Catskill.

Sunday, 27.—Spend the Sabbath in Catskill village.

Monday, 28, 152 M.—Arrive at the Rensselaer School, in Troy, and set about arranging for the passage on the Erie canal. Pack up all our Hudson River specimens, and leave them at the School.

July 1*st*. *Thursday*.—Embark on board the canal boat Surprise, Capt. Goss, at half past nine, A. M. The boat had lain above the Sloop lock, in the Hudson river, before the School, a sufficient time for taking in the Library, Mathematical Instruments, apparatus, tests, specimens, &c. to be used in giving instruction on board.

Friday, 2, 156 M.—Observed the clay slate of Cohoes Falls passing upwards into the wacke variety. Three miles further up the

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* Never petalliferous. See p. 321, Vol. XVIII. Probably Mr. H. found a radiated animal, of the genus anthocephalus. I found such a petrifaction in the same rock at the Helderberg. I had it examined by Le Sueur.

Mohawk, a little below the lower aqueduct, it passes under the first graywacke.

This had been mistaken for second graywacke, on account of the calciferous sandrock, (used as an indifferent water cement,) three miles south, appearing to pass under it. We now discover that it lies under that rock; and that it is the same rock which forms the banks of the Saratoga Lake, and the banks and bed of the Mohawk, from near the Cohoes Falls, to Schenectady.—About midway between the Cohoes and Schenectady, is situated the remarkable crooked slate; being a variety of first graywacke. In it we find abundance of the petrifactions found in siliceous slate, at Hudson, which has been called Sertularia. It resembles the headed ear of barley; and on a former examination was, considered as a culmiferous plant. But, as in numerous other cases, it is often difficult without numerous specimens to decide, whether a petrifaction is animal or vegetable. As the lower orders of animals seem to have been "first endowed with the gift of life," especially in great quantities, we are disposed to refer most of the obscure petrifactions to the grand divisions of radiated and molluscous animals. This opinion has been recently questioned. And stiped and culmiferous plants may have preceded all animals. I leave therefore this petrifaction to future examination. It is generally from one to three inches long, perfectly plumose at its margin, with a body the eighth of an inch in diameter. This is the same rock which is described in this Journal, and illustrated by a drawing of the shore of Saratoga Lake, made by Dr. J. H. Steel.

At the meeting of the argillite and first graywacke, both rocks are remarkably undulated throughout an extensive district, in the bed, banks, and vicinity of the Hudson River. There is a remarkably striking example near the commencement of the Hudson and Delaware Canal on Hudson River at Esopus Strand. In all these places, it seems as if there had been a great effort made by the argillite to force the graywacke from its natural, horizontal position, into the inclined position of the argillite.

175 M. Schenectady. The students visit the Rev. Dr. Nott at Union College, he being president of the school as well as of that college. They are entertained with much kindness.

Sept. 3, 186 M.—Examine the very interesting calciferous sand rock, called Flint Hill. The north side of this rock is cut down and makes the bed of the canal. It is one of the strata comprised

under the carboniferous limerock of European geologists. It contains vast beds of hornstone, very coarse agate, &c. descriptions of which have heretofore appeared in the Journal of Science. We observed the places where this rock passes under the metalliferous limerock, and both under the second graywacke.

208 M.—We distinctly see the calciferous sandrock emerging again and reclining upon the primitive spur, called Root's Nose, which extends down from McComb's Mountain west of Lake Champlain. It next appears in a high bluff inclined against the west side of the spur. In this bluff is a deep narrow cavern. It was carefully surveyed with compass, chain, and other instruments, under the superintendence of myself, by H. H. Eaton, G. White, and Dr. J. Eights, and found to be more than four hundred feet in extent, with a depth of between two and three hundred feet. But after the most diligent search, no antediluvial relics could be found in it; though stalagmites and diluvial mud were found in abundance. In the same calciferous sand rock, opposite to Spraker's Basin, about three miles farther west, we find abundance of semi-opal, and numerous quartz crystals, both containing anthracite.

217 M.—At Fort Plain we examine the beautiful metalliferous limestone in horizontal layers. It is every where perforated with vertical encrinites, (rather stylastrites of Martin,) which, on being polished, constitutes the most elegant variety of birdseye marble. It is not generally compact enough to polish however.

Our boat lay in the mouth of Otsquago Creek during the night, where we observe immense quantities of light carburetted hydrogen gas, perpetually rising from the bottom. It seems that trees, leaves, &c. are brought down the creek, and meeting the still water here, become water soaked, fall, putrefy, and on the usual principle, produce this compound gas.

Sunday 4.—Spend the Sabbath at Fort Plain. The Rev. Dr. Brown performed the service of public worship before the whole party, and such of the villagers as chose to attend.

Monday 5, 233 M.—Go to Little Falls. Here the canal ascends by several locks, across a spur of McComb's Mountain, through a deep natural channel (several hundred feet,) in a rock of slaty granite, gneissoid hornblende rock. Against each side reposes the calciferous sand rock, containing tabular barytes, anthracite, quartz crystals, &c. The students make an excursion on foot to Fairfield Medical Institution seven miles north, for the purpose of collecting quartz

crystals with double pyramids, sulphate of barytes, &c. in the same calciferous sandrock which reposes on the west side of the primitive spur at Little Falls.

Tuesday 6, 255 M.—Boat goes to Utica.

Wednesday 7.—Students visit Trenton Falls on foot, about fifteen miles north of Utica. The banks and bed of the west Canada Creek, on which these falls are situated, are the shelly variety of the metalliferous limestone, reposing on the encrinitic kind. The latter may be seen passing under it three or four miles down the creek. This place is famed for its enormous trilobites and orthocerites. It extends to Sackett's Harbor, where the same petrifactions are found.

Thursday 8.—Students visit Starch Factory Falls, four miles south of Utica. Here is a remarkably abrupt meeting of second graywacke and millstone grit. On ascending this little creek we see the grit pass under the red saliferous rock, that under the gray band variety, and that under the ferriferous rocks. The last embrace all the varieties of argillaceous iron ore, wrought in Westmoreland, &c.

Friday 9.—Fatigue and a damp and rainy season have brought upon me a fever and inflammation of the lungs. I am compelled to put up at a friend's house in Whitesborough. Prof. Edgerton of Utica High School, formerly adjunct Professor in Rensselaer School, takes my place as chief instructor, and the Rev. D. Brown as agent; and at 5 P. M. the boat proceeds on the tour. Hereafter I depend on the notes of the agent, teachers, and students; but having traveled through the whole rout four times, and reviewed important parts of it very often, I am willing to be responsible for the remainder of this journal.

They collect millstone grit of the most perfect kind a mile west of Oriskany: this rock appears in large boulders on the south side of the canal—also in a ledge a little farther south.

Saturday 10, 275 M.—Pass the village of Rome. The great diluvial trough commenced several miles back, but it is most perfectly characterized here. It was perforated forty two feet, at this place, at the expense of Mr. Van Rensselaer. Shells of the unio, and hemlock trees (*Pinus canadensis,*) were found throughout all the perforations. Ascending the side cut about a mile, they laid up the boat at Chiteningo Village, in front of the Polytechny School, with the intention of spending the Sabbath here. Visiting the ledges of lias, two miles from the village, they become acquainted with the process of manufacturing the hydraulic cement. Here is the greatest manufactory of this cement probably in the world.

A mile from the great lias quarry, under the direction of assistant Prof. Sanford, they collected specimens of sulphate of barytes, mostly crystallized, in what appears to be third graywacke. But it may be argillaceous lias.

Sunday 11.—Students attend publbic worship in Chiteningo. The Rev. Dr. Yates, Principal of the schools, treats them with marked civility.

Monday 12, 307 M.—In Manlius, two miles east of the village, they visit Lake Sodom. It is but a few rods south of the canal and scarcely the fourth of a mile in length. It is strongly charged with sulphuretted hydrogen, perfectly limpid, with a beautiful green bottom of disintegrated ferriferous slate, the sides very white shell marle and tufa, and the brim black vegetable mould. Beautiful red fish, and also a white variety of the genus *Cyprinus?* are seen swimming in it, which cannot be distinguished from the Chinese gold fish at the distance of a few feet. The limpid character of the water may be referred to the chemical action of the sulphuretted hydrogen in the precipitation of the metallic coloring matter.

At the little village, called Manlius Centre, a bank on the south side of the canal presents a most excellent view of the lias and its associates. Here it embraces beds of gypsum, vermicular limestone, agaric mineral, &c. Numerous pseudomorphous crystals, imitating crystals of common salt, are found in a soft variety of the lias.

Tuesday 13, 316 M.—Syracuse and Salina. The manufacture of salt by boiling and by solar evaporation is very interesting. Hopper-form crystals are sometimes found in the vats, which will hold half a gill of water. The pseudomorphous crystals of the soft variety of saliferous rock are found here (as well as in the lias of Manlius,) three and four inches in diameter. Conclusive evidence is now deduced from a view of the surrounding rocks, their dip, &c. that Mr. Byington's borings* did not extend through the saliferous rock into the millstone grit; but that the conglomerate masses which he brought up were similar to the beds of breccia or conglomerate often seen in ledges of this rock. It must be at least two hundred feet thick here—probably three hundred. Experience alone will determine the depth of the strongest brine; and also the question, whether or not, solid rock salt may be found in this rock. I am not in possession of any facts from which I can deduce a safe inference. That specimens of this rock, also of the superimposed ferriferous rocks and lias, when left in a damp cellar, do shoot out acicular crys-

* See Mr. Forman's remarks p. 141.—*Ed.*

tals of pure muriate of soda, I can now announce with perfect assurance, having proved it by numerous specimens. And in all these rocks none of the salt could be detected; but its constituents could. That pseudomorphous crystals, perfectly imitating the artificial hopper-form crystals of these vats, are found in lias ferriferous and saliferous rock, is now well known. Let each chemical philosopher deduce his own inferences.

(To be continued.)

2. *Proceedings* of the Lyceum of Natural History, of New York.*

(Continued from Vol. XVIII, p. 195.)

March, 1830.—The anniversary discourse was pronounced by Prof. J. A. Smith. Specimens of hornblende crystals in a siliceous rock from Chester, (Mass.) were presented by Mr. Jessup. Gov. Houston presented a fossil crab from the Dismal Swamp, Virginia, very nearly allied to Cancer undecim dentatus, of Latreille. Mr. E. Thompson was elected a resident member.

April.—Dr. Feuchtwanger read an account of Drebriden's scale of chemical equivalents, and a translation of Frederick Hoffman's observations on the reciprocal relations of the antediluvian flood. Dr. Torrey presented bronzite, (Clintonite,) from Orange Co. N. Y. Mr. Cooper made a detailed report upon the several species of fresh water shells in the cabinet of the Lyceum. These have been presented at different times by Mr. Barnes, Dr. Eights, Messrs. Cooper and Cozzens, and Prof. Troost of Nashville, Tennessee. There are now twenty seven species of the genus Unio, and five species of Symphonota of Lea. The genera Alasmodonta and Anadonta will form the subject of a future report. Several undetermined species were referred to Messrs. Cooper and Lea, for examination and report. Dr. Dekay offered some additional observations upon the teeth of the Mosasaurus, and exhibited the vicarious or replacing tooth of this fossil reptile. He also exhibited another specimen of Coprolite from New Jersey, and compared it with fossil casts of Terebrum, with which it had been confounded. Dr. Hosack presented a collection of plants from Mauritius, prepared by Mr. Telfair. Dr. Van Rensselaer read a paper on the animal poisons of the United States. Colonel Dekay presented specimens of emerald in its gangue from the celebrated mines near St. Fé de Bogota, (Colombia.) Mr. Cooper read a paper on two young skulls

* Forwarded for the last number but received too late for insertion.

of an extinct animal lately discovered in Kentucky and New York, resembling the Mastodon, but possessing lower incisive teeth. Mr. C. thinks that these are no more than the young of the common or great Mastodon, which opinion was supported by arguments derived from the appearances observed in the skulls themselves, as well as by analogous instances occurring in several species of Rhinoceros, the Walrus and many others. Dr. Storer was elected a resident member. The president communicated the intelligence of the decease of Stephen Elliot, of Charleston, and of S. N. Caström, of Stockholm, honorary members.

May.—Dr. Van Rensselaer read a continuation of his paper containing an account of the vegetable narcotic poisons of the United States. Mr. John Shillaber presented a collection of plants from the island of Java. Mr. Halsey, to whom they were referred, reported the collection to consist of about one thousand specimens in an excellent state of preservation, and carefully labelled and arranged by C. L. Blume, a Dutch naturalist of celebrity, who resided at Batavia for several years. Many of the genera named in the present collection, are not mentioned in any work in the library of the Lyceum. Dr. Boyd presents granular Franklinite, yellow blende, and yellow manganesian garnet, from Franklin furnace, N. J. Dr. Torrey reported a list of plants collected in the neighborhood of New Orleans, and sent by Dr. Gates to the western exploring association. A collection of plants was received from a corresponding member, Schomberg, at St. Thomas. Several rare and valuable works were received from Prof. Schreiber, of Vienna. Messrs. O. E. Edwards and H. W. Field, were elected resident members. Messrs. Charles Telfair and Robert Barclay, Bury Hill, England, were elected corresponding members. Prof. Lindley, of London, was elected honorary member, in the place of Stephen Elliot, deceased; and Lt. Gen. Count Dejean, of Paris, was elected honorary member in the place of N. S. Caström, of Stockholm, deceased.

3. *Notices communicated by Dr. Wm. Darlington.*

Loudon's Encyclopædia of Plants, edited by Professor *Lindley*, is a most curious and valuable performance. The editor and publisher seem to have attained the *ne plus ultra*, in condensing scientific information. By means of small types, abbreviations, and various significant characters, they have succeeded in forcing the acquisitions of ages, and the substance of countless volumes, into a single

octavo. The general character of the work, so far as I have examined it, is correct, and highly creditable to the skill and industry of the editor. I am confident it will be found to be one of the most useful and satisfactory manuals, ever offered to the cultivators and students of botany. Still, however, there are some inaccuracies in the volume—some instances of a heedless copying of errors, or of neglect to rectify them,—which ought not to have occurred at this late day, and in a work of this importance. Compilers of the present era, in getting up standard books, should be particularly careful to eschew the blunders and vulgar errors of their predecessors, and prevent the perpetuation of mistakes. This is demanded, not less by the good taste of the age in which we live, than by the interests of science itself. In turning over the Encyclopœdia, I noticed some observations upon the derivation of sundry generic names, which suggested the remarks herein annexed; and if you think them worth the space they will occupy in the miscellaneous department of your excellent Journal of Science, they are entirely at your service.

W. D.

West Chester, Penn., August 28, 1830.

Horæ Botanicæ; or desultory notices of the Encyclopædia of Plants, edited by Prof. *Lindley.* 1829.

Page 131.—"*Logania.*—Named by Mr. Brown, after *a Mr.* James Logan, *said* to have been the author of some experiments upon the generation of plants." We have good reason to believe that there certainly was "*a Mr.* James Logan," once, in Pennsylvania, who was "*said*" to have been a ripe and good scholar, and a munificent patron of the sciences, as well as "the author of some experiments upon the generation of plants." Could not Professor Lindley obtain access to the Transactions of the Royal Society of London, and *see for himself* whether Mr. Logan was not the author of an interesting memoir on that subject, instead of giving the fact as a doubtful *say so?* The memory of James Logan is revered by every lover of science and literature in America, and we think it was entitled to more respectful treatment, even in England.

Page 174.—"*Pinckneya.*—So named by Michaux, after *some American gentleman* of the name of Pinckney, *who is now forgotten.*" If Prof. L. had turned to the excellent work of Mr. Elliott, on the plants of the Southern States, he might have learnt that this plant was so named "in honor of Gen. Charles Cotesworth Pinckney,"

of South Carolina; a gentleman who, although not particularly devoted to the science of botany, was so eminently distinguished among his countrymen, as a soldier, statesman, patriot, and patron of useful knowledge, that he is neither "now forgotten," nor is he likely to be forgotten, on this side the Atlantic.

Page 601.—"*Adlumia.*—A name unexplained by its author, M. Rafinesque Schmalz." We do not know, with certainty, the origin of this name; but presume it was intended as a compliment to our highly respected old friend, *Major John Adlum*, of Georgetown, District of Columbia, who cultivates *the vine* with so much zeal and success.

Page 691.—"*Marshallia.*—Named after *Henry* Marshall, an *Englishman*, author of *a sort* of history of the trees and shrubs of North America, published in 1778." Really, the contemporaries of the late *Humphry Marshall*, must be surprised to find their amiable old friend, who was born, and lived all his days, in Chester county, Penn., transformed into "an *Englishman;*" and that his interesting *Arbustum Americanum*, which first appeared in 1785, is but "*a sort* of history of the trees and shrubs of North America, published in 1778!" The Arbustum Americanum was so much esteemed, that it was promptly translated into German; and, for the time when it appeared, was a highly respectable and useful work. The Professor draws largely from *Pursh*, in compiling his Encyclopœdia; and if he had looked into the preface of that author's Flora, he would have found honorable mention made of the founder of one of the oldest botanic gardens in America. The truth is, the Professor seems to have copied his account, errors and all, from *De Theis*, without taking the trouble to look at Marshall's work; and has gratuitously added the disrespectful phrase, "*a sort* of history." Such careless transmissions of error are hardly excusable in a performance of such pretensions as the Encyclopœdia of Plants.

Page 738.—"*Baltimora.*—This plant grows in *the neighborhood of Baltimore.*" If this remark is intended to intimate that the plant derived its *name* from "the neighborhood" of its place of growth, it is rather equivocally expressed, and probably inaccurate, in point of fact. *Specific* names are frequently, and often injudiciously, imposed, with reference to the place where plants are found; but to give a *generic* name, such as *Baltimora*, *Quebeckia*, or *Londonia*, merely because a plant happened to grow "in the neighborhood" of those places, would be singular enough. Prof. Lindley seems to

have looked, for the derivation, no further than the *Dictionnaire Etymologique* of *De Theis*, who says, "Cette plante croit en Mary-Land, dans le voisinage de la ville de Baltimore." De Theis probably derived his curious *exposition etymologique* from the remark of *Willdenow;* "Habitat in Marilandia, ad urbem Baltimore." If the Professor had consulted Rees' Cyclopœdia, he might have seen that the plant was "so named by Linnæus, in honor of F. C. lord Baltimore, proprietor of Maryland, in North America." As to its growing "in the neighborhood" of Baltimore, *Pursh* says, "I have never seen this plant in any part of the United States, and suppose it to be only an inhabitant of Vera Cruz;" and Mr. *Nuttall* adds, "Probably, as Mr. Pursh remarks, not indigenous to the United States." Dr. *Torrey*, in his Compendium of the Plants "hitherto found in the United States, north of the Potomac," does not mention the Baltimora. Mr. *Elliott* does not notice it among the plants of the Southern States; and *Eaton's Manual* says, "it is doubtful whether this grows north of the West India islands." So that the Professor's elucidation of the *Baltimora*, has not added much to our former stock of light on that subject.

4. *Chart of Long Island Sound*, surveyed in the years 1828, 29 and 30, by Edmund Blunt, published and sold by E. & G. W. Blunt, 154 Water street, New York.

The Messrs. Blunt, father and sons may be considered as benefactors to their country. While our government, though drawing the main portion of its revenues from commerce, has done, comparatively, little towards determining the character of our coast, these gentlemen have come forward, and at great expense as well as labor, have endeavored to supply the desideratum. The harbors of Portland, Portsmouth, Newburyport, Squam, Newport, New York, Georgetown, Charleston and Savannah, the Bahama bank and adjoining keys, the Nantucket shoal, &c. have been surveyed either wholly or in part at their expense. Information of other places has been industriously sought, from the manuscripts of the Navy Department, or wherever else it was to be found, and the result has been books and charts which are of invaluable service on our stormy and dangerous coast. We notice these labors with the more earnestness, as they seem not to have been sufficiently appreciated by the public: their worth is felt among scenes of appalling interest, but these scenes are far removed from our eye; the persons also who feel it,

share too little in our sympathy. The additional security given to our coasting voyages may be inferred from the fact that since the commencement of the efforts of these gentlemen, insurance on vessels in this trade has been reduced one half, and in some cases, even still more than this.

The chart of Long Island sound, we are informed, is from trigonometrical surveys by a Theodolite and Azimuth instrument. The base was measured on Greenwich point, and the triangulation was carried on by means of signals on both sides of the sound. A line of verification on Gardiner's island, shewed an accuracy in the operation, sufficient for the nicest practical purpose. The soundings are full, and were determined by means of angles observed with the sextant, depending in no case on the compass, according to the method first used by Dalrymple, and afterwards systematized by Beautemps Beauprè. The chart is six feet eight inches in length, and in neatness of execution, will compare well with the best foreign charts.

We alluded above to what our government has done, or rather what it has not done on this subject. Why is it, that with a commerce inferior to that of no nation on the globe, with a coast extensive, stormy, abounding in shoals, fringed with numberless inlets, and swept by strong and singular currents, why has government done so little towards ascertaining and helping us to guard against these dangers? We have public vessels enough, and there are now more than a hundred officers on shore, fit, or in a state easily to be fitted for this duty, and earnestly desiring release from the ennui of doing nothing. The English have their survey-ships in almost every sea; their sounding leads have been dropped in almost every furlong of the Mediterranean; France has done much also; even Spain has her whole coast delineated on a set of most beautiful and accurate charts;—on this subject, what has our government done?

5. *Use of Chloride of Lime in the U. S. Navy.*—We are happy to learn that in the U. S. sloop ———, recently returned from a cruise in the West Indies, the chloride of lime has been employed with good success. The offensive smell of the bilge-water was instantly removed by dropping into it a small quantity of this article. The efforts of the officers to sweeten water for their table was not so successful. The smell was removed, but the taste of chlorine remained. Had they however passed the water through pulverized charcoal, previously well ignited, they would have obtained it per-

fectly healthy and pure. We have heard the bilge water in our packet ships loudly complained of: a useful hint may be taken by these vessels from the above.

Use of Chloride of Lime on board a Spanish fleet, in the summer of 1829; from the National Intelligencer, of June 5th, 1830.

To the Editors.—We have been favored with the perusal of the reports from the surgeons of the Spanish fleet, directed to the Commandant-General of the station at Cuba, respecting the use of chlorine, which are highly interesting; affording additional evidence, if more could be required, of the extraordinary powers of that article in changing an atmosphere rendered highly offensive and pernicious to health, to one devoid of effluvia, and perfectly salubrious.

On the 11th of July last, the fleet destined for the invasion of Mexico, conveying, in addition to the usual compliment of mariners, a large number of soldiers, was overtaken in the Gulf of Mexico by a violent tempest, which continued for several days. The severity of the storm rendered it necessary to remove the windsails, and to close, not only the ports of the lower gun deck, but likewise those of the main deck, and to place on the hatches. In this condition of the ships, with such a crowd of persons confined together, in the middle of summer, within the tropics, without fresh air, putrid fever and malignant dysentery soon made their appearance. The air is described as possessing, in addition to a highly offensive effluvium, an acrid heat, burning to the skin, with a degree of density that arrested respiration and produced giddiness.

At this moment of distress and anxiety for the safety of all on board, the chlorine was used with the most decided and happy effects. Twelve vessels, containing one ounce each of the chloride of lime, in solution with water, were suspended on the birth deck, four were placed on the orlop deck, and two in the gun room. In the space of two hours, the atmosphere lost all its deleterious qualities, and became perfectly agreeable, leaving nothing perceptible but the smell of tar, which always exists more or less in ships. The solutions were renewed every twenty four hours; but the chloride undissolved at the bottom of the vessels was then sprinkled on the decks, and thrown into such vessels as it became necessary to cleanse. During the whole of the campaign, which lasted three months and a half, the atmosphere was preserved in this pure state by the chlorine, to which all the surgeons unite in attributing the very few instances of

death that occurred in the fleet, when there existed such fruitful sources of fatal disorders.

In these reports we find the experiments of Labarraque confirmed. Putrid meat, immersed for two hours in a solution of one part of the chloride of lime with forty parts of water, after being several times washed in fresh water, lost its disagreeable odor, and became as agreeable to the taste as if no putrefaction had ever taken place. It is likewise added, that the chloride never incommoded in the least the healthy or the sick. Two cases of pulmonary consumption were particularly noticed, in which not the least irritation of the lungs could be perceived.

While inviting public attention to the signal virtues of the chlorine, it should not be confounded with the disinfecting gases of Morveau and Carmichael Smith, so much condemned in Trotter's Medicina Nautica.*—B.

6. *Use of chloride of lime in bleaching the pulp of rags prepared for making paper.*—Having been consulted by a distinguished manufacturer of paper in Massachusetts, as to a remedy for the injuiry sustained by his people from the effluvia arising from the use of the chloride of lime, we obtained from him the following statement of facts.

"In an engine room (so called) we have four engines that grind the pulp of paper. These engines contain three hogheads of water, in each of these we put one hundred and sixty pounds of rags, and after washing them well in the engine, and reducing them to coarse pulp, we put into each engine five pounds of the powders dissolved in a pail of cold water and after grinding the powders to get them to pieces, we strain this water into the engine and repeat the operation two or three times to get out all the strength of the powders into the engine. After the powders have been in the engine about fifteen minutes, we put half a pint of oil of vitriol into a pail of water, and when well mixed turn it into the engine. This bleaches the rags in about twenty minutes, we then hoist our washers and wash out the bleaching powders and vitriol. You observe that in this operation we use no hot water, nor is there any acid or other taste in the water, even when we use a pint or a pint and a half of vitriol."

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* The quantity of the chloride of lime proposed to be furnished to a ship of the line, by the Spanish surgeons, in their report, is fifteen pounds a month, which in this city would cost about two dollars.

We recommended aqua ammoniæ to be placed on the upper lip and in the nostrils, for the purpose of neutralizing the chlorine by the production of muriate of ammonia.—*Ed.*

January 14, 1830.

7. *Professor Hitchcock's lectures on diet, regimen and employment.*—These able and interesting lectures were delivered last year to the students in Amherst College, and are worthy of the attention of all students, and indeed of all persons. We trust that the Journal of Health, the Journal of Humanity, and the Lectures of Prof. Hitchcock, seconded by other valuable publications, are doing and will continue to do much for the promotion both of the *physical and moral* health of the community.

Professor Hitchcock has justly urged the necessity of temperance and selection in the use of food as well as of drink, and although under the latter head, we may differ from him in some details, and may think some of his opinions carried to an extreme, we do think his main argument sound and irresistible, and we believe that no one will rise from a perusal of his book (so well sustained by facts and authorities as well as by reasoning,) without a disposition *to be temperate in all things.*

In Vol. XVI, p. 327 of this Journal, mention is made of a ship which sailed from New York for China without any spirit on board, and this without the knowledge of her crew, who were however provided with abundant comforts of every other kind. The captain of the ship wrote from Whampoa, China, to his employers under the date of October 7, 1829. "Your experiment of sending us to sea without ardent spirits has thus far proved most satisfactory; I have not heard a murmur on the subject, and my crew have been on shore and returned sober, a case unparalelled in the annals of Whampoa." The ship has since returned to New York and brought the same crew of sober, contented, efficient men, all ready to enlist again upon the same terms, and the proprietors of the vessel, (principal navigation merchants of New York) "are so well convinced that liquor is worse than useless on board of their vessels, that in no one has any been sent during the past year."—*Ed.*

8. *On frogs and toads in stone and solid earth,* by David Thomas, Esq.—The permanent existence of living animals in situations where atmospheric changes appear to be impossible, being still regarded by many persons as a matter of dubious authority, the fol-

lowing extract of a letter from David Thomas, Esq., late engineer of the Erie canal, to Prof. J. Griscom, furnishing some authentic information on this question cannot fail to be interesting to physiologists.

'The report that a living toad was found in limestone rock at Lockport in 1822, I well remember. I had never heard it doubted, but was too much occupied at the time, to make very particular enquiries. The following is the evidence that I have lately obtained on this subject:'—

Dr. *Isaac W. Smith* recollects that "In preparing jambs from limestone, thrown out in excavating the Erie canal at Lockport in 1822, *John Jennings*, a man of unimpeached veracity, declared, that on breaking into a cavity in the stone, a toad fell out, and jumped several times. It soon died, and that evening it was purloined for the purpose of selling it at Albany as a curiosity. Perhaps at that time, no person in Lockport doubted the truth of this statement, as the cavity in the jamb stone, perfectly suited to such a tenant, was open to inspection, and *may now be seen* in the underpinning of *Wm. C. House's* store in Lockport."

My friend *George H. Boughton*, (now of the senate) in a letter, dated, Albany, March 1, 1830, says, "The circumstances of the toad's being found in the solid rock in the summer of 1822, are all familiar to me, but none came under my personal observation, except *the stone*, said to have contained it.

"*Jennings*, the man who related the fact, was preparing jamb stones for a counting room in the store occupied by Mr. *House* and myself. The stone was taken from the canal, then excavating, some four feet below the surface, [detached from the solid rock, and surrounded by earth.]

"The stone had been marked out for the jamb, and on breaking it to the line, it broke through the centre of the cavity, leaving about one half in the face of the jamb. The toad, which was represented to be of the small brown kind, fell out, and after jumping two or three times, (not more) expired. I passed along a few minutes after, and had the relation from *Jennings*, but did not see the toad. He said some Irish laborers came along just at that time, and took it away with them. I was too much engaged, and thought too little of it at the time (much to my regret since) to seek them out, and obtain the animal.

"Jennings was directed not to work the cavity out, and it stood for years in our counting room, where you may remember to have

seen it. From the cavity to the outer edge of the stone at its nearest point, was probably three or four inches, and *was perfectly solid all around.*

—"I never doubted the correctness of Jennings' statement. All the circumstances seemed to confirm it."

'No direct evidence on this subject can be obtained, but Dr. I. W. Smith states, that "in 1822, a small boulder of porous red sandstone was thrown out in digging my cellar at Lockport; and as it was found near the top of the *spoil-bank*, its position probably had been five or six feet below the surface. On discovering something to project from this stone, I broke it, and found it to contain a frog,—not living, for it had been exposed some days to the sun; but from its appearance, was probably alive at the time it was thrown out. The stone and frog are both preserved in my cabinet."

'In the deep excavation beyond (south of) the rock, on the line of the Erie canal, between Lockport and the Tonnewanta, it was several times mentioned to me by the contractors, that *frogs were taken up alive from considerable depths, entirely surrounded by solid earth.* I never happened to be present at such removal; neither was Dr. I. W. Smith, nor G. H. Boughton, though both well recollect the report, and the latter says in his letter to me, before cited,' "I well remember to have been told at the time by Mr. Norton's foreman, in whom I had entire confidence, that such was the fact. That one in particular was found I think more than ten feet down, embedded in the close, firm clay and alive."

On this subject, *Ebenezer F. Norton* of Buffalo, (Member of Congress, above referred to) in a letter to me dated Washington, Jan. 24, 1830, says "In answer to the enquiry respecting frogs and toads, I can only say generally that nothing was more common than to find very far from the surface of the earth, these animals apparently in perfect health and vigor."

'I have collected the foregoing information with the hope that it would be interesting to Naturalists, and that it might induce others to observe more particularly similar facts. But the evidence is less positive than I had anticipated, and I leave it to be disposed of, as shall appear best.'

'I could procure a certificate from *Dr. Stephen Mesher*, relative to removing a frog or toad, some two or three feet in solid earth, and which he believes to have been a diluvial deposit. *Jonathan Swan*, deceased mentioned a similar case to me.

N. B. In *William's History of Vermont*, (which I read many years ago,) I think there are several statements respecting the discovery of live frogs at great depths.

Greatfield, 5mo. 1, 1830.

9. *Character and description of a new species of Ulmus, with a drawing; by* David Thomas.

Ulmus racemosa.—*Specific character.*—Flowers in racemes; pedicels in distinct fascicles; united at their bases.

A tree. *Lower branches*, with irregular corky excrescences. *Leaves*, ovate, acuminate; auriculate on one side; doubly serrate; above, glabrous; under side and ribs, minutely pubescent. *Racemes*, of several fascicles, (often three or four, with a terminal flower;) 1 to 2½ inches long—from the sides of the last year's branches, and often garnished with small but perfect leaves, before the terminal buds open. *Fascicles* of 2—4 flowers. *Flowers*, pedicellate. *Calyx*, 7—8 cleft. *Stamens*, 7—10. *Stigmas*, two, recurved. *Samara*, ovate, pubescent; membrane more extended on one side; margin densely fringed.

A native of Cayuga county, in the state of New York, and of the adjacent country.

10. *On the occultation of Aldebaran, in a letter to the Editor, dated July* 24, 1830; *from J. Thompson, Prof. Math. in Nashville Univ.* (*Tenn.*)—In order to obtain the difference of longitude accurately between different places, it has been frequently recommended to compare corresponding observations of occultations, lunar transits, &c. made under the meridians of those places whose longitudes are required, the result of which would be free from the errors of the tables. But although the method recommended offers obvious advantages, few are enabled to avail themselves of the results of observations made by others, as no concerted plan has been adopted by astronomers in this country of making their observations generally known.

In the American Almanac on the subject of occultations, the following particulars are proposed for observation at the time of an observed occultation.

1. Whether the star undergoes any change of light, of color, or of motion, on its immediate approach to the edge of the moon.

2. Whether it appears to be projected on the moon's disc, and if so, for how long a time.

3. Whether the dark limb of the moon be distinctly visible and well defined at the time of the phenomenon.

4. Whether the star on its emersion, appears on the moon's disc, or emerges quite clear of the moon's border.

At the time of the occultation of Aldebaran on the 16th inst. I could not discover any change either of light, color, or motion on the approach of the star to the edge of the moon, except that the rays proceeding from the star appeared to have a tremulous motion about the time of immediate contact. The star appeared to be in contact with the edge of the moon about two or three seconds before its total disappearance. The time of total disappearance I took for the time of immersion. From the time the star appeared to have come in contact with the moon until it wholly disappeared, which was about two or three seconds, the star evidently appeared projected on the moon's disc. This however was not so much the appearance of a real star, as it was of a few bright rays that seemed to diverge from the point of contact. In seeking for an explanation of this phenomenon, I placed at about two feet from the eye, a small sparkling object, which gave something of the appearance of a star, then by bringing the edge of an opaque object between the eye and the luminous point, so as just to intercept the rays proceeding from the latter to the eye, about one half of the sparkling object seemed projected on the opaque body, and presented an appearance very much resembling the projection of the star on the moon's disc at the time of occultation. May not the appearances in both cases proceed from the same cause?

The dark limb of the moon was distinctly visible during the greater part of the time the star was concealed, until about the time of emersion, when the sun approaching near the horizon prevented it from being seen. An accidental movement at the time of emersion prevented me from noting the precise time of the star's reappearing, hence in obtaining the longitude, only the time of immersion could be depended on.

The time of immersion was at 4h. 6′, 17″ apparent time, A. M. the longitude of the moon thence deduced was 66°, 36′, 11,3″ which compared with the same longitude in the Nautical Almanack, gave for the longitude of Nashville 5h. 47′, 27″ in time, which agrees very nearly with the mean result of a considerable number of observations of Jupiter's satelites.

11. *Effect of certain mineral poisons on living plants, in a letter to the Editor, from Dr. Hare.*—In order to destroy the caterpillars which feed upon them so ravenously, I was desirous of ascertaining how far certain poisonous solutions could be introduced into the circulation of plants without injury to them. Having cut off a few twigs from a Linden tree, I introduced a twig, with its leaves attached, into different phials of water, severally impregnated with iron, copper and arsenic; also one into pure water. That introduced into the ferruginous solution, died in about twenty four hours. The twig exposed to the copper lost its proper hue and looked sickly in about two or three days, and finally appeared dead in about five days. Nearly five days had elapsed before the twig in the arsenious acid, although saturated, became sensibly injured, and even then it was only changed in color. During the first three days no difference could be perceived between the leaves of the twig here mentioned and that sustained by pure water. It would appear from these experiments that metallic solutions are poisonous to a vegetable in the inverse order from that in which they affect animals, and that small portions of arsenic may be introduced into trees, so as to be poisonous to the insects which destroy their foliage. On macerating a leaf of the twig in the arsenious solution, only about forty five hours after it was introduced into it, the water to which it was subjected gave with the ammoniacal nitrate of silver a yellow precipitate, and after five or six days, this experiment being repeated, a copious precipitation ensued, indicating arsenite of silver. Caterpillars put upon the leaves impregnated with the arsenic died in a day or two, excepting one which was too far advanced to eat. These observations in your Journal, so hastily made and described, may need some indulgence from your readers.

12. *Notice of a Barn Swallow, in a letter to the Editor dated Windsor, Turky Hill, June 7th,* 1830, *from Samuel Woodruff.*—This bird is one size larger than the common barn swallow, and more garrulous; tail not forked, but full and square; plumage about the head and upper side of the neck of a shining black, with the exception of a cross bar of white on the forehead immediately back of the beak; breast and belly a light brown; a narrow longitudinal stripe of a dull white on the back; rump a light brown, tinged with yellow; wings much of the color of the barn swallow, but less pointed.

They are remarkably gregarious, and cluster together in great numbers on barns where they find the jutting of the eaves to suit their convenience. Under these they build their nests, never entering the barn.

But the most distinguishing trait in their character consists in the mode and form in which their nests are built. The only material which they use for the exterior part is mud. They begin by plastering on the side of the barn about twelve inches below the projection of the eaves. As they ascend in the work, they enlarge it by a gradual and handsome swell so that the form is elliptical, and of such a size that the nest would hold a quart. As they proceed in their work and approach the eaves, they contract their domicil, giving it at the same time such a curve as to leave the entrance through a neck, the end of which is turned downward. The aperture is round, about one inch and half in diameter. Every other part of the nest is closed with a sufficient mud wall and ceiling. They are excellent masons as well as peaceable neighbors among themselves, building their nests so that in many instances they are in contact with each other, and in some, considerably lapped, so, however, as not to obstruct the free ingress and egress of each proprietor. I, this morning, counted twenty two nests upon the south side of one barn, all fully tenanted, and all within a line of twelve or thirteen feet in length. I understand they build their nests only on the southerly side of barns.

13. *New pyrophorus, by Dr. Hare.*—When Prussian blue is heated to a red heat for about a minute in a glass tube and then sealed up, it constitutes a pyrophorus. As soon as the tube is fractured, and the mass included thrown out upon a table it takes fire.

Remark.—We presume of course, that if duly prepared and transferred for keeping, to an air tight bottle, it would become ignited if poured out into the air.—*Ed.*

14. *Transactions of the Albany Institute.*—The number for June 1830, contains papers on the following subjects.

An account of a man who lived on water fifty three days, by Js. M. Naughton.

Monograph of the Cones of the United States, by Prof. Jacob Green, with a plate.

Observations on the coal formation of the states of New York and Pennsylvania, by Prof. Eaton.

On the Dolia of the United States, by Prof. Green.

Address before the Lyceum of Nat. Hist. of the Institute, by Dr. T. R. Beck.

Note respecting the Ranunculus lacustris, by Dr. Lewis C. Beck and James G. Tracy, with a plate.

Reclamation of salamanders in a letter to Baron Cuvier, by Jacob Green.

List of officers—history of the Institute, with an abstract of its proceedings.

The Institute appears from its transactions, of which the present is No. 4 of Vol. I. to be in a flourishing state, and from its position and the activity of its members, it cannot fail to aid the general cause of knowledge.

We have copied into the present number of this Journal the paper of Prof. Eaton on the coal formation.

15. *American Annals of Education and Instruction, and Journal of Literary Institutions, embracing a record of schools, colleges, and lyceums*; conducted by William C. Woodbridge, assisted by several friends of education.—The title of this Journal sufficiently indicates its objects. The editor is well known to the public as the author of a popular system of Geography. After residing for a number years in various parts of Europe, and making himself intimately acquainted with the different methods of instruction practised there, he has commenced the work before us, with the benevolent and patriotic design of offering to his country the fruits of all his inquiries.

He hopes still further to advance the cause of education by eliciting the sentiments of others engaged in the same pursuits, and he will render a most acceptable service to the cause of education, should he be the means of making known more generally the views of men so well qualified, both by native originality and acquired wisdom, to interest and instruct the public as is the gentleman whose name we are happy to meet with several times in the course of these two numbers. The title of the articles already published, will give our readers a more particular view of the nature of the work. They are as follows: Progress of Education in Germany and Switzerland—Biographical sketch of Fellenberg—Sketch of the Fellenberg Institution at Hofwyl—Infant education—Review of the Report of the Manual Labor Academy of Pennsylvania—Asylum for the blind—Methods of teaching to read—Carstairian System of Penmanship—Literary

Notices—System of classical Education in Bavaria—Philosophy of Language—Lectures on School Keeping—English Schools of Boston—Deaf and Dumb Institution—New Institution at Cuba—County Conventions—Music as a branch of Instruction in Common Schools—Progress of Female Education—Jacototian System of Instruction—Practical Lessons—Convention of Teachers. We cordially recommend this enterprise to public patronage. While so many unsettled and discordant opinions prevail in our own country respecting the methods of education, and while in this inventive age, so many experiments are instituted on this subject, we consider the appearance of such a work as peculiarly seasonable and important.

16. *American steel.*—We with pleasure insert the following notice of the excellence of the steel manufactured at New York by Mr. Clark; no testimony can be derived from better authority.—*Ed.*

Whitney Ville, Sept. 24th, 1830.

To Prof. Silliman.—*Sir*,—At the 111th page of the 17th volume of the Journal of Science, you gave a notice of the efforts of Mr. O. L. Clark of New York to improve the manufacture of American steel, to which is subjoined an account of the result of several trials to which a specimen of his steel had been subjected at this place.

Mr. Clark still continues his patriotic efforts in this branch of the arts, and I am happy to state to you that he has recently presented us with another specimen of his steel, which was subjected to the same tests as that referred to above; all of which it endured as well as the best English steel. Very respectfully yours,

E. W. Blake.

17. *A collection of colloquial phrases on every topic necessary to maintain conversation; by A. Bolmar.*—Carey & Lea, Philadelphia, 1830.—This little book appears well arranged for the purpose of facilitating the acquirement of the French language.

18. *Culture of Silk.—Extract of a letter to the Editor, from Dr. Felix Pascalis, dated New York, July* 26, 1830.—The culture of silk goes on succcessfully; I hear flattering accounts from every quarter of the Union. At the next fair of our Institute, I shall be able to exhibit a great number of domestic silk productions, in the highest perfection.

Having been presented, by my friends in Paris, with a few Chinese mulberry trees, *Morus multicaulis*, intended by me to be immediately propagated, I have been able, through the skill of an excellent gardener, to obtain, in four months, no less than seven trees from two only, in perfect and full growth. Nothing is more astonishing than the success with which that plant can be propagated. Its leaves are twelve inches long and nine or ten wide, and absolutely thin and fine. Before the opening of the winter, I hope to be able to present one to every agricultural institution of the country. With this it is no longer problematic that two crops of silk can be obtained in one season.

19. *Protection for Steam Boilers.*—Dr. Comstock, of Lebanon, Conn., in a letter to the Editor, suggests the plan of incasing the whole boiler with timber, placed at a proper distance; the thought is a good one, but in our judgment no plan will answer which does not remove the boiler out of the frequented part of the boat; and in two articles in the present number, we have suggested a plan which we conceive would obviate, in a great degree, the mischief arising from the explosion of boilers on board of steam boats.

Notices Translated and Extracted by Prof. Griscom.

CHEMISTRY.

1. *Sulphuric acid produced by the vapors of the Aix waters.*—The hot mineral waters of Aix, in Savoy are two in number, and are distinguished, one as the aluminous, the other as the sulphuretted. It has frequently been stated that the vapours of the former contained free sulphuric acid. That they produce sulphuric acid, is proved by the following observations of Mr. Francœur. First, All the grottoes, closed chambers, corridors, &c.; where the vapours penetrate, have their walls corroded and covered with acid crystals of sulphate of lime. Secondly, All iron utensils, &c. are not only corroded, but are often found encrusted with sulphates of iron and lime. Thirdly, Tubes of cloth, through which the vapors are passed, are quickly rotted, and the rags are found impregnated with sulphuric acid. No free sulphuric acid exists in the water itself, and from the circumstances, it follows that the mixture arising as vapor, and containing hydrogen, azote, sulphur, and carbonic acid, has the power of producing sulphuric acid by means of the atmosphere, and in contact with the walls and metals.—*Annales des Mines.*

2. *Crystallization of Barley sugar.*—The change in appearance arising from crystallization, which sticks of barley sugar undergo in keeping, is always instanced as a case of crystallization occurring in a solid body without solution, and independently of external agents. The barley sugar certainly does not then become a hydrate, and probably at the completion of the change is exactly of the same weight as before it began. But it would appear that the presence of a little moisture is necessary for the change, and probably that every portion of barley sugar which suffers this change has been successively loosened, and held in solution by that small portion of water which begins to act on the outer surface of the stick and travels inwards. Two fresh sticks of barley sugar, dry and transparent, were introduced at the same time into separate phials; one of them with a stick of caustic potash, and the other by itself, corked up and laid in a drawer.

The barley sugar in company with the caustic potash, which would preserve it perfectly dry, did not undergo the slightest alteration in six months, but remained as transparent as at first. The barley sugar in the other phial was scarcely altered during the first four months; but during the last two months, which were colder and damper, it became opaque on the surface, and the crystallization thereafter was propagated inwards to a considerable depth.—*Quarterly Journal.*

3. *Vegetable crystallization.*—Various naturalists have taken notice of the appearance of crystals in the internal parts of vegetable tissues; but nothing very explicit and certain has been stated respecting them. M. Turpin has discovered in the cellular tissue of an old trunk of the *Cereus Peruvianus*, in the garden of plants at Paris where it had been growing one hundred and thirty years, an immense quantity of agglomerations of crystals of oxalate of lime. They are found in the cellular tissue of the pith and bark. They are white, transparent, foursided prisms, with pyramidal terminations, collected in radiant groups.—*Rev. Encyc. Mars*, 1830.

4. *Disinfecting powers of chloride of lime.*—M. Poutet of Marseilles says, that this substance cannot be used with advantage in destroying the bad odor of fish or marine animals, for that it evolves one as bad as any they can previously possess. The powder added with a little water to fresh or salt fish, cut into small pieces evolved

such an odor of bromine as to be insupportable. The muscle of putrid fish produces a still worse smell, and the same thing took place with other marine products, as shell fish, sponges, &c.—*Quarterly Journal of Science.*

5. *Impure salt in France.*—An account has lately been given to the Academy of medicine, of certain impurities in common salt. The salt used in Fere-Champenoise and the neighborhood having induced violent cholic, accompanied with swelling of the face, in many of the inhabitants, M. Cosmenie has examined it, and found in it bromine, bromide of sodium, iodine, and iodide of potassium. Several of the members had been charged with the examination of the salt used in Paris. M. Baruel had met with some containing iodine. M. Chevallier had examined many specimens of salt that had been seized, but had not found iodine in any of them. Some of them had been adulterated by the admixture of sulphate of soda.—*Bulletin Universelle.*

6. *Theory of Voltaic Electricity*, by Prof. Pfaff, of Kiel.

In a letter to Gay-Lussac, of 15th July, 1829.

Prof. de La Rive, of Geneva, having in an able memoir (which was republished in the Ann. de Chim. of Nov. 1828) furnished some striking results to prove the incorrectness of the fundamental thesis of the theory of Volta relative to his pile, viz. that of the production of electricity by simple contact, and to demonstrate that *in all cases* it is *chemical action* which determines this production—Prof. Pfaff still holding to the theory of Volta, that contact alone generates the electrical excitement, opposes the results of Prof. de La Rive, with reasonings and experiments which appear at least very plausible.

Prof. de La Rive maintains that the humidity of the hand, which holds or touches the metal, and the oxygen and moisture of the air in contact with the plates, are circumstances essentially concerned in the electromotive power, and which are of course referable to chemical action. Prof. Pfaff objects to the correctness of some of the experiments relative to the effect of more or less moisture of the hands, and observes that his results are opposed to those of Professor de La Rive.

But to prove that oxygen and moisture are by no means necessary to electrical excitement in the contact of different metals, he formed a condenser of a plate of copper and a plate of zinc, substituting in

some of the experiments a plate of tin in lieu of the zinc, and covered their surfaces with a thin coat of varnish. One of these plates was screwed to a gold leaf electrometer. The effect of the moisture of the hands was in this manner excluded, and in order to obviate the objection of atmospheric agency, the apparatus was placed under a receiver, and so adjusted that the experiment could be made either in a vacuum or in a dry atmosphere of any kind of gas. It was thus found that whether the electrometer with the condenser was surrounded with common air, moist or dry, with oxygen, azote, carbonic acid, hydrogen, or carburetted hydrogen, *the results were the same.* Under these varying circumstances the *electric tension* was found to be the same; and it seems impossible to ascribe the effects to any thing but the contact, and a sound philosophy would lead to the inference that the circumstances which alone did not vary must be taken as the cause of the phenomenon, namely, the reciprocal contact of the metals themselves. To succeed well in these experiments, the condenser must be very perfect, the metallic plates made very smooth and even, and then covered with a very thin coat of amber varnish. With an instrument which condenses three hundred times, and with gold leaves of one sixth of an inch wide and two inches long, Prof. P. commonly obtained a divergence of half an inch.

To these direct proofs that chemical action is not necessary in the production of the electricity of contact, may be added indirect arguments drawn from facts which M. de La Rive has not explained. If it is chemical action exerted upon an oxidable metal which is the source of electricity, whence proceeds the difference of the electric charge of the condenser in employing different plates, such as silver, copper, tin, lead, touched in all cases with the same zinc plate? How shall we explain the series of tensions which the metals, their sulphurets and some of their oxides form, and the fixed law of this series established by Volta, and confirmed by so many experimenters. It is well ascertained that copper is near the middle of this series, the extremities of which, are, on one hand hyperoxide of manganese, and on the other zinc (abstracting the metals of the alkalies and earths which are below zinc). If in the contact of zinc and copper it is the oxidation of the zinc which produces electricity, how is it produced in the contact of copper and gray manganese? Another fact appears irreconcilable with the chemical theory, according to which the energy of the electric current ought to be

proportionate to the energy of the chemical action. A solution of pure sulphate of zinc deprived of interposed air, either by heat or by the air pump, and which exerts no chemical action either on the copper or zinc, produces an electric current more energetic than the the solutions of all other salts with the exception of sal ammoniac. What is the chemical action also in the electric current produced by the thermo electric pile?—*Ann. de Chimie. Juillet.*

MECHANICAL PHILOSOPHY.

1. *Shocks by the electric currents.—Professor Marianini* of Venice maintains that there is a difference between the contractions produced by the immediate action of electricity on the muscles, (which he calls *idiopathic,*) and those which arise from its action on the nerves which preside over the motion of the muscles, (which he names sympathetic.) Idiopathic contractions are produced when electric current takes either direction, while the *sympathic* are produced only when the current passes in the direction of the ramification of the nerves. Hence, when an electric current is passed through a limb in the direction of the nerves, the two shocks are simultaneous; but, if the current proceed in the other direction the idopathic contraction only is perceived.

If the right hand touches the positive pole of a battery, and the left the negative, the shock is felt more forcibly in the left arm; but if the current passes in the other direction, the right arm is more affected than the left.

If one hand communicate with the positive pole, and one foot at the same time with the negative pole, the shock is much stronger in the leg in which it is both idiopathic and sympathic, than in the arm, where it is only idiopathic. The same difference ensues in passing the shock from the shoulder to the hand, from one foot to the other, from the thigh to the foot, &c. This difference is greater in some persons than in others, especially if paralytic. In a man affected with hemiplegia, the shock was very strong when the current passed from the shoulder to the hand, but was scarcely sensible in the other direction.

In some cases of paraplegia this difference is perceived only in one member. A woman who had lost the use of her lower limb by an inflammation of the spinal marrow, was shocked in her left foot more strongly when in contact with the negative pole; but the right foot

was shocked equally with either pole. This appeared to be occasioned by the right limb's having lost the power of receiving the sympathetic shock.

If a finger be dipped into a cup of water, which is in connection with the positive pole of a battery of thirty pairs, as high as the second phalange, and the negative pole be touched by a metallic rod held in the other hand, also moist, the shock is felt in the finger as high as the second phalange; if the direction of the current be reversed, it is felt as high as the third phalange. The first shock is also perceived to be more superficial and attended by a sensation somewhat painful, while the second is deeper, and no sensation is perceived when the finger is in contact with the water. In the latter case, the shock is both idiopathic and sympathic; in the former, the current goes in a direction contrary to the branching of the nerves, and instead of producing a shock it gives rise to a sensation.

If a metallic rod covered with a wet cloth, be taken in each hand and the poles of a battery of thirty or forty pairs be touched, there is felt beside the shocks, every time the circuit is closed, a particular sensation in the palm of the hand, touching the positive pole. With some persons very sensitive to electricity, this sensation is like that which is experienced in the hands or feet after the nerves have been for some time compressed.

These facts, if more thoroughly examined, may probably lead to some useful results, especially in cases of diease.—*Bib. Univ. Decem.* 1829.

2. *Elastic force of steam.*—M. Dulong, in the name of a committee of the Academy of Sciences, made a report on the 30th of November, "of experiments made to determine the elastic force of the vapor of water at high temperatures, by order of the Academy." Dulong and Arago, who had been specially charged with the experiments, thought best to measure the tension of steam by the compression of atmospheric air. The first thing was to satisfy themselves of the permanency of the law of Marriotte at high pressures, a permanency which had never been verified. They accomplished this by means of a tube seventy or eighty feet high, erected in a tower of the old church St. Genevieve. In thirty nine experiments, made upon a mass of air subjected to a pressure from 1 to 27 atmospheres, the law of Marriotte was found to prevail without the least appreciable deviation. This first point being established, they were

enabled to measure the tension of steam, within these limits, by its action on a mass of air. The following table shows the results, which have been extended to 24 atmospheres by experiments, and it was carried up to 50 by interpolation, by means of the formula $e=(1+0.7153t)5$, in which e is the elasticity, t the temperature, and 1 the pressure of the atmosphere. This formula represents, with sufficient exactness, all the results furnished by experiment, as far as 24 atmospheres; the confidence which the committee of the Academy placed in it is such that they are convinced that at 50 atmospheres, the error could not amount to more than 0.1.

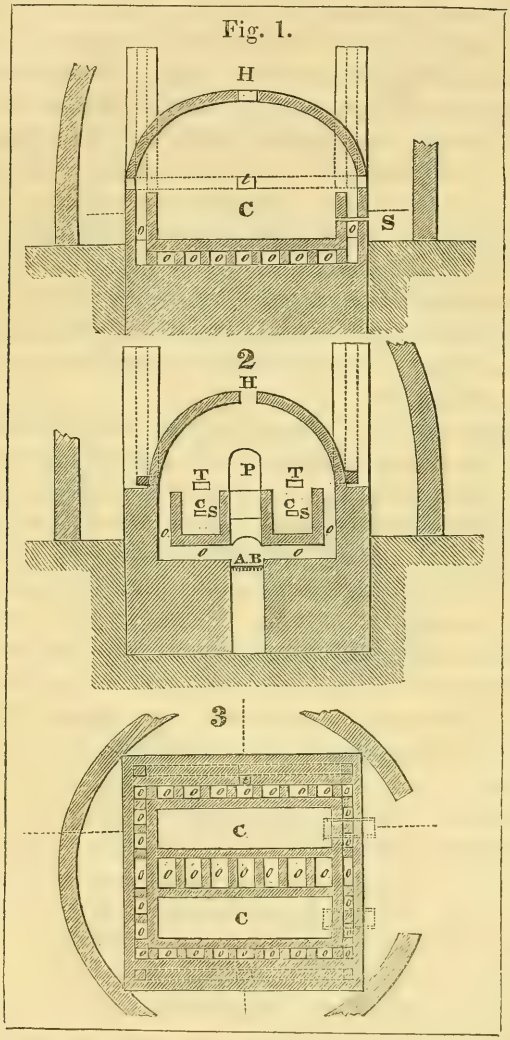
Table of the elastic force of steam at temperatures corresponding with 1 *to* 50 *atmospheres.*

Elasticity, atm. press. being 1.	Temperature, Centigrade.	Elasticity, atm. press. being 1.	Temperature, Centigrade.
1	100.	13	193.7
1½	112.2	14	197.19
2	121.4	15	200.48
2½	128.8	16	203.60
3	135.1	17	206.57
3½	140.6	18	209.4
4	145.4	19	212.1
4½	149.6	20	214.7
5	153.8	21	217.2
5½	156.8	22	219.6
6	160.2	23	221.9
6½	163.48	24	224.2
7	166.5	25	226.3
7½	169.37	30	236.2
8	172.1	35	244.85
9	177.1	40	252.55
10	181.6	45	259.02
11	196.03	50	260.89
12	120.		*Idem.*

3. *Note on the fabrication of steel at Sheffield in Yorkshire; by* MM. Coste and Perdonnet.—*By cementation.*—Steel of cementation (blister steel,) is made at Sheffield of Swedish iron, by a process which has been often described, and relative to which, we shall

not therefore go into details except to describe the cementing furnace, the exact dimensions of which we have been able to procure.

Figs. 1, 2, and 3, show the arrangement of the furnace. It is rectangular and covered by an arched vault; it contains two cement-



ing troughs C, constructed of brick.* These troughs are two and a half feet wide, three feet deep, and twelve feet long; they are placed on each side of the grate, A, B, fig. 2; the latter extends

* These troughs are sometimes made of refractory stone.

the whole length of the furnace, which is from thirteen to fourteen feet; it is fourteen inches wide and is from ten to twelve inches below the bottom of the troughs. The height of the culminating point of the vault above the trough is five feet six inches. The bottom of the troughs is nearly on a level with the floor, so as to prevent the necessity of lifting the bars of iron very high in charging the furnace.

The flame rises between the two troughs, passes underneath, and circulates around them by openings, or vertical and horizontal canals, *o*, fig. 1, 2, and 3; it issues from the furnace by an opening H, in the centre of the vault, and by holes *t*, which communicate with chimneys placed in the angles. Some furnaces are noted for a greater number of chimneys symmetrically disposed around the structure. In others, the partitions are pierced with vent holes, which are opened during the cooling. The whole furnace is situated in a vast cone of brickwork from twenty five to thirty feet in height, open at the top. This cone increases the draught, regulates it, and conducts the smoke out of the establishment.

The furnace has three doors, two T, fig. 2, above the troughs which serve for the introduction and withdrawal of the bars; they are seven or eight inches square. In each of them is fixed an iron plate, turned up at the edges, on which the bars rub without injuring the wall. A workman enters by the middle opening P, to arrange the bars; and by the holes S, fig. 1, in the sides of the trough, the trial bars are drawn out.

The bars are arranged in beds, in the cementing troughs, with powdered charcoal. They are about three inches wide and four lines thick. They must not be placed too near each other, lest they become soldered together. The last layer (which fills the trough,) is formed of clay, and is four or five inches thick.

The furnace is gradually heated, attaining its greatest intensity in about eight or nine days. The cooling which must be progressive, lasts five or six days, and the whole operation from eighteen to twenty days, and sometimes longer, according to the intended quality of the steel. There are consumed, during this time, about thirteen tons of pit coal.

Fabrication of cast steel.—Cast steel is made of blistered steel or steel of cementation. It is broken into pieces, put into an earthern crucible, and heated in a common wind furnace. This furnace is a foot or fourteen inches square, and two feet deep.

It is closed on the top with a moveable cover composed of bricks bound together by an iron band. Several of these furnaces extend along a wall and are connected with a wide chimney. The top of them is on a level with the floor, and their common ash pit is a cellar about ten feet high.

The crucibles, of very refractory clay, are sixteen or eighteen inches deep and five inches in diameter. About forty pounds of steel are melted in them in five hours. In a state of fusion, it fills rather more than half a crucible; the latter are simply covered with an earthen slab. One of them cannot serve for more than three operations.

No fuel is used but good coke; that which has been prepared in ovens is preferred. The melted steel is poured into moulds held perpendicularly, and when full, an iron weight is laid on the top to prevent the melted metal from boiling out of the mould, but not so heavy as to increase much its density.—*Ann. de Chimie, Tom. VI*, 105.

4. *Hydrostatic balance.*—Different kinds of apparatus have been invented for demonstrating the hydrostatic paradox of Pascal, viz. that the pressure of fluids is in proportion to their depth, and that at equal depths it is the same whatever may be the form or capacity of the containing vessel. The following arrangement is proposed by De Haldat, in the transactions of the Royal Society of *Nancy*.

A simple syphon is inverted, filled with mercury, and one of the branches is enlarged in order to be adapted to different vessels; and the other branch, more narrow, is provided with an index which shews by the invariableness of the mercurial column, the equal pressure upon the common junction of these vessels of unequal capacity.

5. *Hydrostatic press.*—In the same volume is described a very simple and cheap and at the same time powerful, hydrostatic press, invented by Débuisson an architect of Nancy. It is composed essentially of a large leather bag, in the room of the large cylinder of common hydrostatic presses. This bag, fifteen inches in diameter, is placed in a wooden cylinder, the sides of which are strengthened by iron bands. The bag, by expanding in this cylinder, presses upwards a wooden platform on which are placed the materials to be compressed, and which are confined as usual between cross beams strongly jointed in a frame. A lad of twelve or fifteen, can by this machine exert a pressure of seventy to eighty thousand pounds. The

leather bag is rendered very tight and strong by means of copper rivets.—*Idem.*

6. *Extinguishment of fires in chimnies.*—A few pinches of flowers of sulphur thrown at short intervals upon the coals or wood burning in the fire place, will speedily extinguish the most raging fire in a chimney. A wet cloth should be hung before the fire place. This method has been effectually tried at the mint in Paris, and has received the sanction and recommendation of D'Arcet, Huzard, Labarraque, Pelletier, Berard and other reporters. The sulphurous vapor has also the advantage of pervading the crevices and ramifications of the chimney and completely finishing the combustion. A pound of sulphur has effectually put out, in a few minutes, a fire in a tall chimney when the flame rose three or four yards above the top. —*Idem.*

7. *Lightning rods.*—It is proposed by John Murray of London, in a recent treatise on Atmospherical Electricity, that every lightning rod should be composed of four wires, each one fifth of an inch in thickness, bound together by rings of copper. This compound rod should extend several feet above the highest part of the building, and at the top each wire should branch out at an angle of 45° and end in a point. The rod should be fastened to the building by wooden clamps. At two feet from the ground, it should incline outwards and on entering the earth each wire should branch out again, and terminate in a moist situation. In order to preserve the rods from oxidation he recommends that before they enter the ground they should pass through a cylinder of zinc.

The author supposes that an extensive multiplication of these rods might have an effect of meliorating the climate, and also that in hop fields, if wires of copper were made to project upwards from a sufficient nnmber of the poles, they would operate as a preservation against that dampness which, by weakening the vegetative powers of the plant, invites the attacks of the Aphis or fly, which so often proves destructive.—*Rev. Encyc. Fev.* 1830.

8. *Indian corn.*—This grain, so important to the agricultural interests of the United States, appears to be of uncertain origin. Fuchs very early maintained that it came from the east, and Mathioli affirmed that it was from America. Regmir and Gregory have presented

fresh arguments in favor of its eastern origin. Among them is the name by which it has been long in Europe, *blé de Turquie*, and varieties, it is said, have been brought from the Isle of France, or from China. Moreau de Jonnés, on the contrary, has recently maintained in a memoir read before the Academy of Science, that its origin was in America. The name *blé de Turquie* no more proves it to be of Turkish origin than the name of *Italian poplar* proves that that tree grew wild in Italy. It can only signify that it spread from Turkey into the neighboring countries. Its general cultivation in southern Europe, and the production of some new varieties, proves nothing with regard to the country of the species.

In favor of its American origin, is the fact that it was found in a state of cultivation in every place where the first navigators landed; in Mexico, according to Hernandiz, and in Brazil according to Zeri, and that in the various countries, it had proper names. Such as *Maize*, *Flaolli*, *&c.* while in the old world its names were either all of American origin, or names of the neighboring region whence it was immediately derived, and that immediately after the discovery of America it spread rapidly in the old world and soon became common, a fact not reconcilable with the idea of its former existence there.

To these proofs Aug. de Saint Hilaire has added another. He has received from M. de Larranhaga of Montevideo, a new variety of Maize distinguished by the name of Tunicata, because instead of having the grains naked they are entirely covered by the glumes. This variety is from Paraguay where it is cultivated by the Guaycurus Indians, a people in the lowest scale of civilization, and where, according to the direct testimony of one them, it grows in the humid forests as a native production.—*Bib. Univ. Jan.* 1830.

9. *Heat lightning.*—The flickering motion of lightning, sometimes styled *vespertine*, observable in the clouds near the horizon, after a warm day, unaccompanied by thunder or any sound whatever, is ascribed by Huber-Burnaud, in a letter to the editors of the Bib. Univ. to thunder storms at so great a distance that not only the sound of the thunder cannot possibly reach the ear, but that the curvature of the earth conceals the clouds which are concerned in the electric discharges almost entirely from the sight. The lightning which we observe in those cases, he considers as only the flashes of light which break through the highest stratum of the thunder cloud, and which dart into a region so elevated as to become visible at a very great

distance, and in situations where no clouds appear. To regard these flashes as arising from electrical discharges in an air in which there is no condensation of vapor in the form of cloud, he pronounces to be unphilosophical, and maintains that if electricity becomes thus visible, the phenomena should sometimes be seen in or near the zenith, whereas it is always observed near the horizon. A person situated on the summit of a high mountain, while a thunder storm is raging beneath him, at so great a distance as scarcely to be heard, he supposes to be in a position analogous to the spectator of the noiseless flashes of a summer evening.

The editors of the Bib. Univ. dissent from these views of Huber-Burnaud. The fact that these lightnings are sometimes seen all around the horizon proves, in their opinion, that they cannot be attributed to distant thunder storms; and although it is rare that these heat lightnings are seen in the zenith, yet there have been instances of their appearance over the head of the observer. The production of electric light requires only a rarefied state of the atmosphere, either by the effect of heat or by the presence of aqueous vapors. Such an atmosphere becomes a conductor, through which the discharges become visible from one portion of the air to another, and in such gentle streams as to afford light without noise.—*Bib. Univ. Nov.* 1829.

10. *Determination of metallicity.*—The simple and ingenious method which Dr. Wollaston employed to discover metallic titanium in the scoria of iron, and to prove the metallicity of the small crystals of titanium, was to place a card or slip of paper between a plate of zinc and another of copper, make a small hole in the card, into which he inserted the crystal to be examined, and then plunged the apparatus into diluted acid. If the substance placed in this opening is a metal, bubbles of hydrogen will be disengaged; but if not metallic, this effect is not produced. The paper disk prevents the electric action of the two surfaces, and nothing but a conductor of the most perfect kind, thus inserted between them, in the small opening, will establish it. Thus lead, bismuth, tin, give bubbles on the copper; while the oxide of titanium, sulphuret of arsenic, gray cobalt, sulphuret of antimony, iron pyrites, galena, tin ore, &c. have no effect. Two specimens of meteoric stone, introduced into the circuit, showed, by bubbles of hydrogen, the presence of uncombined metal, and it has been found, by the ingenious experiments of Macaire-

Prinsep, that lead and sulphur combined, in varying proportions, from $\frac{1}{100}$ to $\frac{1}{12}$ of sulphur, did not prevent the formation of bubbles; but when the sulphur was increased to $\frac{1}{8}$, no more bubbles appeared; upon critical investigation he ascertained that the proportion of sulphur to the lead, at which the action ceased, was precisely that of common sulphuret of lead; and the same experiments having given the same result, with respect to the sulphuret of tin, he inferred that the proper combination, in determinate proportions, is necessary to prevent the metals in contact from producing electricity, and that the influence of the mere mixture was nothing. This result he deems of some consequence to the mineralogist.—*Bib. Univ. Fev.* 1830.

11. *Daily Magnetic Variation.*—According to experiments made by Humboldt, it appears that the daily variation is by no means the same in different places. On the 29th of January, the variation at Berlin was three times greater than on the 27th; whereas, at Paris, on the 29th. it was much less than that of the 27th. at Berlin. At Berlin, the variation, on the 11th. of January, was twice that of the 10th. at Paris; that of the 10th. was greater than that of the 11th.

These results do not appear to depend on any error of observation, but are real consequences of local causes. By trials made at the mouth and lowest part of the Freyberg mines, it was found that at a depth of seven hundred and ninety eight feet in the earth had no sensible influence upon the inclination of the needle.—*Quarterly Journal of Science.*

12. *Economical process for Imitating Silver paper.*—The following Chinese method has been made known in Europe by Pere du Halde :—Take two scruples of gelatine, or Flanders' glue, made of ox-hide, one scruple of alum, a pint of water. Place the whole over a slow fire until the water is almost wholly evaporated. Spread some sheets of paper upon a table, and with a brush lay on two or three coats of this glue; then take powder made of a certain quantity of talc boiled, and one third of the same quantity of alum. After having well pounded these substances, sift them, then boil them again in water, then dry them in the sun, and pound them again. The powder, which is then very fine, is to be passed through a very fine sieve upon the sheets of prepared paper. The talc powder is glued fast: it is then to be dried in the shade; after which remove the superfluous powder with a piece of cotton.—*Jour. des Connoiss. Usuelles.*

13. *Pressure of Sand.*—From a letter by M. Huber Burnaud to Professor Prevost, on this subject, the following conclusions may be drawn. In a given time, the quantity of sand which flows is constant, whatever be the height of the column and the pressure which it is made to undergo. Sand flows through a fissure from two to three millimetres in diameter, in the direct ratio of the length of the fissure. A greater diameter induces an increase in the flow which surpasses the simple proportion of the surface of the orifice. Some grains of sand isolated upon an inclined plane, flow only when the inclination has attained thirty degrees. Sand in a heap presents itself, after the flowing off of its mass, under an angle which varies from thirty to thirty three degrees. If sand be poured into the branch of a syphon which contains mercury, the latter does not change its level in the opposite branch. There must be concluded from this that the weight of the sand is almost entirely supported by the walls of the tube. The author has verified this conclusion by direct experiments. The same phenomenon took place in conical tubes, the mouth of which was turned downwards, provided the inclination of its walls did not exceed thirty degrees.—*Bulletin des Sc. Mathematiques.*

14. *Cement from Iron Filings.*—M. Mailtre having reflected upon the action of vinegar in the preparation of the cement known as *mastic* le limaille, which is made of iron filings, garlic and vinegar, so proportioned as to form a mass of moderate consistency proposed to substitute for the vinegar sulphuric acid diluted with water, in the proportion of one ounce to a little more than two pints of water, and to reject the garlic as useless. This alteration was soon adopted by all to whom he communicated it in Paris, and will save in Paris alone more than ten thousand francs annually. This cement is there employed to close the seams of the stones with which terraces are covered. The iron filings becoming oxidized, occupy a larger space, their oxidation being facilitated by the action of the acid, and the joints become exactly closed.

15. *Concentration of Sound.*—It happened says Dr. Arnott, once on board a ship sailing along the coast of Brazil, far out of sight of land, that the persons walking on deck, when passing a particular spot, always heard very distinctly the sound of bells, varying as in human rejoicings. All on board came to listen, and were convinced; but the phenomenon was most mysterious. Months afterwards it

was ascertained, that, at the time of observation, the bells of the city of St. Salvador, on the Brazilian coast, had been ringing on the occasion of a festival; their sound therefore favored by a gentle wind, had travelled perhaps one hundred miles by smooth water, and had been brought to a focus by the sail on the particular situation or deep where it was listened to. It appears from this, that a machine might be constructed, having the same relation to sound, that a telescope has to sight.

16. *Dangerous Plant among Water-Cresses.*—The procumbent water parsnip, *Sium nodiflorum*, is a dangerous plant of the umbelliferous class, which grows mixed with water-cresses in springs and streams. When not in flower, it so much resembles the latter, that it is with difficulty distinguished except by a botanist. Water-cresses are of a deeper green, and sometimes spotted with brown, and the extremities of the leaves are more round, and especially the last leaves, which are in pairs, larger than the others, and undulated at their edges. The water parsnip, on the contrary is of a uniform green; the ends of its leaves are longer and narrower, conical at the extremities, and toothed at the edges. The best method of knowing them well is to examine them in July, when their flowers are expanded, and when they may be thoroughly distinguished from each other.—*Quarterly Journal of Science.*

17. *Thunder Storms in France.*—The Count de Triston has made observations on the direction of the thunder storms which have devastated the department of the Lorich for the last sixteen years. The following general inferences have been made by him, respecting the progress and intensity of thunder storms in plain countries intersected by shallow valleys. Thunder storms are attracted by forests. When one arrives at a forest, if it be very obliquely, it glides along it; if directly, or if the forest be narrow, it is turned from its direction; if the forest is broad, the tempest may be totally arrested. Whenever a forest, being in the path of a thunder storm, tends to turn it aside, the velocity of the storm seems retarded, and its intensity is augmented. A thunder cloud, which is arrested by a forest, exhausts itself along it; or if it pass over, is greatly weakened. When a large river or valley is nearly parallel to the course of a thunder storm, the latter follows its direction; but the approach of a wood, or the somewhat abrupt turn of the river or valley, makes it

pass off. A thunder cloud attracts another which is at no great distance, and causes it to deviate from its course. There is reason to believe that the action is reciprocal. A cloud attracted by a larger, accelerates its motion as it approaches the principal cloud. When there is an affluent cloud, which was committing ravages, it sometimes suspends them on approaching the principal mass, which is perhaps a consequence of the acceleration of its course, but after the union the evil generally increases. Twenty one thunder storms, whose course has been distinctly traced, have extended from N. N. W. to S. S. W. No destructive thunder storm has come from any other points of the horizon. Lastly the position and form of the forest of Orleans, Blois, &c. satisfactorily accounts for the frequency of hail storms in certain communes, and their rare occurrence in others.—*Bulletin des Sciences physiques.*

STATISTICS.

1. *Mortality of infants.*—It has been well ascertained in France and other countries that the mortality of children within the first month is much greater in the cold, than in the temperate seasons of the year. The opinion entertained by some persons that the constitution of a child is strengthened by plunging it soon after birth into cold water, is exploded by every sound physiological principle, and is believed only by the ignorant. In a paper read at the Academy of Sciences in Feb. 1829, by MM. Villermé and H. Milne Edwards, the following table is given of the deaths of children in France under three months old in the years 1818 and 1819.

Months.		1818.	1819.	Mean.
January,	one death in	7.22	8.11	7.66
February,	"	7.67	8.18	7.92
March,	"	8.33	8.55	8.44
April,	"	8.57	9.68	9.12
May,	"	9.80	9.99	9.88
June,	"	9.81	9.62	9.71
July,	"	9.48	9.84	9.66
August,	"	7.81	8.29	8.05
September,	"	8.38	7.76	8.07
October,	"	8.88	8.18	8.53
November,	"	9.29	8.40	8.84
December,	"	7.86	7.82	7.84

The greater mortality of three winter months is here very apparent. It will be seen also that the excessive heats of August and September are more unfavorable than the milder temperature of spring and autumn. The difference of the two years corresponds also with the difference of the mean temperature of those years, that of 1818 being during the winter months 3.4° and of 1819, 4.3°.

It is found also that in the northern parts of France the mortality during winter is considerably greater than in the southern. In 1818 the deaths were to the births in the north as 1 to 7.96, and in the south, as 1 to 10.72. In 1819 (a colder season,) the proportion in the north was as 1 to 9.12, and in the south 1 to 11.70.

These facts, strengthened by numerous others, show the importance of guarding new born children assiduously against the effects of cold, and of the imprudence or inhumanity of conveying them to church at this early age, during the rigorous season, for the purpose of baptism.—*Ann. d'hygiene publique, Jan.* 1830.

2. *Phthisis pulmonalis in Paris.*—The total number of deaths in Paris during the year of 1828, was twenty four thousand two hundred and ninety nine, of which eleven thousand four hundred and thirty were males, and twelve thousand eight hundred and fifty nine females.

The deaths by pulmonary consumption were one thousand one hundred and thirty three men, and one thousand five hundred and twenty six women, in addition to which six hundred and eighty eight men, and eight hundred and fifty one women died of chronic pulmonary catarrh, (which is almost identical with prolonged phthisis) making a total of four thousand one hundred and ninety six, or more than one sixth of the whole number of deaths.—*Idem.*

3. *Establishment of a model farm in Greece.*—The government has just founded an establishment from which important results may be expected, in favor of a country afflicted by the ravages of war, and still more perhaps by the idle and military habits which have resulted from them. Gregory Palaiologue, one of the young Greeks who has pursued a course of agricultural studies at the institution of Roville, in France, has returned to his country, in order to devote his knowledge, perfected by the management of a large agricultural establishment which had been confided to him in Corsica, to the benefit of his country. He embarked with a considerable

provision of instruments, seeds, &c. supplied by the committee at Paris. Capo D'Istria has placed at his disposal a national domain, situated between the village of Dalamanara and the ruins of the ancient Tirynthus, for the purpose of a model farm. His first care will be the sowing of the grain brought with him, the creation of a nursery, and the tillage of the ground by instruments unknown in that country. Prospects of extensive benefit attach themselves to the institution of Palailogue. It must become a focus of light, which will distribute throughout Greece the knowledge requisite to the successful cultivation of a soil so long watered with human blood. But many years must still elapse before this desirable object can be completed. Europe, in delivering Greece, has not finished its work. Enriched by the arts of peace, is it not our duty to devote a portion of what they have furnished us to enable our brethren of the east to enjoy their benefits?—*Rev. Encyc. Mars*, 1830.

4. *Science in Madrid.*—It appears, by a letter from Professor Casaseca, addressed to the editors of the Revue Encyclopedique, that there are in the city of Madrid three distinct establishments for instruction in the sciences, supported at the expense of the government. The *first* is the *Museum of Natural Sciences*, which is divided into two parts; the *Museum*, which contains a beautiful cabinet of natural history, including one of the richest collections of minerals in the world. In this institution are given courses of lectures on mineralogy, zoology and mathematics, well attended; the *botanic garden*, containing a rich collection, among which is the Flora of Bogota, Santa Fé, &c. Connected with the garden are public lectures on botany and agriculture, attended by a numerous auditory. At the termination of each scholastic year, prizes are distributed to the most meritorious students. The Museum of Natural Sciences is under the direction of a learned committee, and the king has given his hearty sanction to a proposition from the committee to establish three additional courses, viz. general chemistry, physics and astronomy.

Second, the *Conservatory of Arts and Trades*, including models of the various kinds of machinery. In this institution are given three courses, viz. geometry, physics, and applied mechanics; drawing, with a particular reference to the delineation of machines; and chemistry, applied to the arts.

Third.—The *direction* of *Mines* in which is given a course of docimastic chemistry.

Besides the foregoing, maintained at the expense of the government,—there is a school of Pharmacy in which are given public lectures on Chemistry, Physics, Botany, Mineralogy, Zoology, Experimental Pharmacy, Materia Medica, with the advantage of a superb Laboratory, and a rich collection of apparatus, minerals, vegetables, &c. The courses are said to be followed with great zeal.

Heretofore there existed in Spain no other public instruction than that of Jurisprudence, Theology and Medicine. Now, the career of the sciences is open and is followed by the young Spaniards, with an assurance that the knowledge thus acquired will obtain for them an honorable existence.

Professor Casaseca conducts in an able manner the department of Chemistry in the Conservatory of Arts.—*Idem.*

5. *Hygiéne.*—At Metz in France, a public course of Lectures, attended by more than two hundred persons is given on Hygiéne, the art of preserving health. The precepts and instruction delivered in this course are printed and distributed among the families of the city.—*Idem.*

6. *English Universities.*—From the last published statements of the number of students at our Universities, it appears that Cambridge has now a majority over that of Oxford, having increased in the last year one hundred and eighteen members. The present total of Cambridge scholars is five thousand two hundred and sixty three, while that of Oxford is only five thousand two hundred and fifty nine.—*Edin. Lit. Gazette, April,* 1830.

ADDITIONAL EDITORIAL SELECTIONS.

1. *Dr. Mitchell's Method of working Caoutchouc.*—Soak the gum elastic in sulphuric ether, until soft and nearly inelastic, which in good ether will take from ten to twenty-four hours. Then if it is a plate, cut it with a wet knife or parallel knives, into such sections, or sheets, or shapes, as may be desired, and suffer them to dry; or if a bag, apply a pipe or stop-cock, and inflate with the mouth; if the bag should expand equally, inflate rapidly, but if unequally, proceed more slowly and with occasional pauses. By such means a

bag may be made so thin as to become transparent and light enough to ascend when filled with hydrogen. By graduating the extent of inflation, a sheet of caoutchouc of any given thickness is produced. If for blow-pipes, or other purposes for which it is desirable that the bags should possess contractility, let them be inflated to the desired size, and after an hour let out the air. Ever after they will suffer as great a degree of extension, and again contract. If permanent sheets are wanted, the inflated bags are to be hung up until dry, after which no sensible contraction will ensue.

Bags softened by ether may be stretched readily by the hand, over lasts, hat blocks, or other moulds, so as to assume the shape desired, and may be so applied to a variety of useful purposes. In the form of straps and twisted strings, its elasticity offers many useful applications. It is easily formed into tubes to connect apparatus, &c.

Some of the bags have been extended to six feet in diameter; one of these being filled with hydrogen, escaped, and was found one hundred and thirty miles from the place. A bag, originally the size of an English walnut, was extended until fifteen inches in diameter.

Dr. Mitchell states, that oil of sassafras softens caoutchouc so that it can be applied with a brush, and that upon drying by exposure to air, it becomes again simple elastic caoutchouc. Many applications of it as a varnish, in this state, are suggested.—*Franklin Journal*, v. 122.

2. *Strength of Wine and other Bottles.*—M. Collardeau has constructed a machine for the purpose of trying the strength of wine bottles. It has been presented to the Académie des Sciences, and reported upon by M M. Hachette and D'Arcet. The bottle to be tried is held at the neck by means of a lever, having three branches, which grasp it below the ring; being then filled with water, it is connected by means of pipes, with a forcing-pump, the pipe having a cap furnished with leather, which is firmly held down by the apparatus upon the mouth of the bottle; the pressure upon the parts here increases with the pressure of the water within the bottle. Besides the pump, levers, and connecting pipe, there is also a manometer connected with the interior of the bottle to shew the pressure exerted. When a bottle is burst in this way by the hydraulic press, no violent dispersion of its parts takes place, unless indeed, in place of being *filled* with water, a portion of air is left in; then when it breaks it flies to pieces, and would cause danger if exposed.

Bottles intended for the manufacture of brisk Champagne or Burgundy, being tried, were found to break with a force between 12 and 15 atmospheres, exerted from within outwards: a few rose to 18 atmospheres. Bottles which had contained Champagne of the finest quality, broke at the same pressures. Bottles which resisted the pressure of 12 atmospheres, usually broke with one or two atmospheres more, but the number of these was small. The fracture of bottles in the manufacture of brisk Champagne is from 10 to 20 per cent; and in certain cases, which, however, are rare, almost the whole have been broken. It appears quite certain, that during the fermentation of the wine, the pressure rises above 12 atmospheres, but the full extent can be ascertained only by careful experiments made by the wine proprietors.

The commissioners then remark, that the best bottles intended for brisk wines are too weak; the general fault is want of strength and uniformity in the belly of the bottle, especially at the junctions with the neck and with the bottom.

As the greater number of bottles for brisk wines are of the same quality, it becomes a question why some should break and others not. This difference is supposed to depend upon the form of the neck and quality of the cork, allowing a little gas to escape in some cases and not in others. If the bottles and corks were all alike, all those which contained the same liquor at the same temperature would probably break at the same pressure. The only means of avoiding fractures is either to make the bottles sufficiently strong, or to allow a little escape of gas by the cork. The least thickness of glass in the belly of the bottle should be 2 millimetre (.079 of an inch,) but generally it is only 1 millimetre at the part next to the bottom.—*Bull. Univ.* E. xiv. 80.

3. *Magnesium. Metal of Magnesia.*—M. Bussy has stated at the Academy of Sciences that he has been able to eliminate the base of magnesia by a process similar to that practised by M. Wohler, and he submitted a specimen for examination.

Magnesium has a brilliant silvery white appearance; is perfectly malleable and ductile; is fusible at a moderate temperature; like zinc, is volatile at a temperature somewhat higher, and may be condensed again into small globules. It does not decompose water at common temperatures, but is oxidized in the air at high temperatures when in small masses, and gradually forms magnesia. Its

filings burn with brilliancy, emitting sparks like iron in oxygen. It is imagined that this metal may be useful, and M. Bussy is engaged in searching for a cheap and easy mode of reducing it.

4. *Decrepitating Common Salt—Condensation of Gas in it.* Dumas.—M. Dumas has examined and described a very curious effect which occurred when some rock-salt, obtained from the mine of Wieliczka, in Poland, and given to him by M. Boué, was put into water. It decrepitated as it dissolved in the water, and gradually evolved a sensible portion of gas. The bubbles of gas were sensibly larger when the decrepitations were stronger, and the latter frequently made the glass tremble. This salt owes its property of decrepitating, to a gas which it contains in a strongly compressed state, although no cavities are sensible to the eye. When the experiment was made in perfect darkness no light was disengaged. The gas disengaged is hydrogen slightly carbonated; when mixed with air it burns by the approach of a light.

This disengagement of gas will assist in explaining the numerous accidents which have happened from fire-damp in salt-mines. Several portions of the salt were nebulous, others were transparent. The nebulosities indicated the existence of numerous minute cavities, probably filled with condensed gas, and, in fact a nebulous fragment, dissolved in water, gave more gas than an equal-sized fragment of the transparent salt.

This new fact, described by M. Dumas, shews how frequent, in the course of geological accidents, are the phenomena to which are due the accumulation of gas in the cavities of mineral substances, and how varied are the substances upon which these phenomena have been exerted. M. Dumas has endeavored to reproduce salt having the power of decrepitating in water like that described.—*Revue Encyc.* xlvi. 245.

5. *Manufacture of Bicarbonate of Soda.*—M. Creuzberg has found a ready mode for the manufacture of this salt, in the circumstance that the dry alkalies absorb carbonic acid much more quickly than those in solution. Carbonate of soda is therefore deprived of much of its water by efflorescence, and is then subjected to a current of carbonic acid gas until the bicarbonate is formed; the time when this takes place is rendered evident by the evolution of heat, and the exhalation of water, which is deposited in drops upon the interior of the vessel.—*Bull. Univ.* A. xiii. 134.

6. *Russia Diamond Mines.*—When in the year 1826, Professor Engelhardt undertook a scientific journey into the Uralian Mountains, he remarked that the sands in the neighborhood of Koushra, and those of the platina mines at Nigny-Toura, strikingly resembled the Brazilian sands in which diamonds are found. Baron Humboldt, during his late residence in the same country, confirmed this resemblance; and examinations having been made according to his advice, a young countryman who was employed in washing the auriferous sand, on the grounds of the Countess Polier, discovered a diamond on the 20th of June last, which was in nothing inferior to those of Brazil; soon after, many others were found superior in weight to the first. Thus Russia has added this source of riches to those which of late years it has obtained in the form of gold and platina mines from the Ural chain of mountains.—*Revue Encyc.* xlv. 460.

7. *Extract of letters of Dr. Comstock to the Editor on the cause of the premature explosion of gun powder, particularly in blasting of rocks; dated Lebanon, Con., Nov.* 9, 1829.—On the first day of June, 1825, my professional attendance upon two men at Bozrah Ville, was requested in consequence of the premature ignition of the charge in a rock which they were preparing to blast, both of whom were severely injured, and one of whom, a Mr. Swift, remains nearly blind.

Upon a minute enquiry respecting the origin of the fire, I became convinced that it could not have arisen from any collision between metal and stone, as the wire was copper. At the instant of the explosion one of these men was in the act of striking down the covering of the charge with a sledge weighing fifteen pounds, and I am disposed to think that the fire in this, and perhaps in other cases of premature ignition, originated from the compression of the air in the hole of the rock. Any one who has seen the little instrument called a *fire pump*, and who has seen fire obtained by a stroke of the hand upon its piston, cannot be a moment at a loss to account for the origin of the fire in this and in similar instances, depending upon the condensation of atmospheric air, and the friction of the piston evolving heat or electricity, or probably both. It appears to me scarcely to admit of doubt, that this is the true cause, and this opinion is fortified by the fact that an explosion of powder both in muskets and in artillery sometimes happens whilst the charge is ramming down, and the origin of the fire has often been considered as unaccountable. But if the

touch hole is stopped air tight by the powder, the gun with the ramrod is then converted into a complete *fire pump*. The vent of artillery should never be closed whilst the charge is ramming down, as is sometimes done by the finger of an assistant, and the pans of muskets and pistols should always be left open; yet, after all, if the chamber of a gun is rendered air tight by the stoppage of the vent by the powder, it is easy to conceive that by the ramrod and wadding the gun may at once be converted into a fire pump, and that, by a violent thrust of the ramrod, fire may be generated between the wad and powder. The only safe course is, therefore, not to use very great force in driving down a charge; and to keep the head and body averted from the mouth of the piece.

But in relation to blasting rocks, the most proper substance for confining powder, is a plug of green wood with either a hole through it, or a small semicircular excavation in one side of its whole length which may be filled with powder, and fired after the plug is driven in. It is apparent that the hole or excavation in the plug will prevent the compression of the air; and that, while dry wood might be suspected of exciting the electric spark by friction against the sides of the hole in the rock whilst driving it forcibly down, that green wood will not have that effect. Since the above accident I have, in a few instances, seen this method tried successfully by my own advice.

March 24, 1830.—The principle of the *fire pump*, (so far as I am informed,) not having been considered in its application to forcing down the wadding or covering of powder in a rock, I am induced to call your attention to the fact that it is often done, with great force and violence; as was the case in the instance at Bozrah Ville. The two workmen, who were there blown up, were alternately employed in striking down the covering, which was of pounded brick, on to the powder with a sledge weighing fifteen pounds!

The method adopted by your correspondent* of covering the charge of powder with a wooden cone, and filling the interstice with sand, steers clear of the principle of the *fire pump*, and is perhaps the best method yet discovered.

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* See the paper of Mr. Blake, Vol. 17, p. 134.

ADDITIONAL EXTRACTS, BY PROF. GRISCOM.

1. *Force* of vapor at different temperatures.*—The committee appointed some time ago, by the French Institute, to determine the elastic force of the vapor of water, at high temperatures, consisted of Baron de Prony, Arago, Gerard and Dulong. The solution of this important question appears to have been assigned to Arago and Dulong, and the result is contained in a report made by Dulong to the Institute, on the 30th of November, 1829. The series of experiments which were prosecuted by them, in order to settle the question upon the most elaborate and solid foundation, was evidently such as does credit to the talents and ingenuity of these distinguished savans. The report at large is contained in the Annales de Chimie et de Physique, Tome XLIII, p. 74, with figures descriptive of the apparatus employed. It concludes as follows.

"The Academy may perceive the result of our experiments is, 1st, a verification of the law of Mariotte, as far as 27 atmospheres; 2d, a table of temperatures, corresponding to the tension of vapor, which does not exceed 24 atmospheres.

These researches, always troublesome and often dangerous, might have demanded many years of assiduous labor. Interruptions, which other duties and circumstances beyond our control have occasioned, have long protracted their conclusion. This delay cannot in justice be ascribed to our negligence. Only persons accustomed to physical experiments upon a large scale, can appreciate the magnitude of the task imposed upon us, with which there is nothing in our archives to be compared, and which has occasioned on our part a devotedness, which the Academy would not probably deem it right to exact from any of its members. We shall not however, regret the time we have bestowed upon it, if the Academy is of opinion that we have worthily fulfilled the commission entrusted to us, and if respondent to the wishes of the government, the results that we present, shall be considered by philosophers as an acquisition useful to science."

The following table exhibits the height of a column of mercury supported by steam, equal to the pressure of 1 to 24 atmospheres, as determined by experiment, and of 24 to 50 atmospheres, by calculation. See the table, page 182.

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* A shorter notice on this subject, was printed at p. 181 of the present No. and this notice has been received since.

2. *Safety of steam boilers.*—By a Royal Ordinance in France of March 27, 1830, it is decreed that every boiler employed in public works or manufactories, where steam is equal to two atmospheres and over; shall have

1. Two safety valves of equal dimensions, and each of sufficient size to discharge the steam freely in case of its too great tension.

2. Each valve shall be loaded by *direct* pressure, and without the intervention of a lever with a weight equivalent, at most, to one atmosphere.

3. Near one of the valves on the top of the boiler, there shall be adapted a metallic plug, fusible at the temperature of 127° centigrade (= 260.6° Fahr.). This plug shall be of such a diameter that its free surface shall be four times as great as that of one of the safety valves.

4. One of the valves and the fusible plug shall be locked up under the same grated enclosure, and the key shall remain in the hands of the principal of the establishment. The other valve shall be under the direction of the engineer of the machine.

5. Each boiler shall be furnished with a manometer open to the air, the glass tube of which shall terminate at the height of twenty eight inches (French) above the level of the mercurial surface pressed by the vapor.—*Bull. D'Encour. Avril*, 1830.

3. *Translation of the Mecanique Celeste, by N. Bowditch.*—We perceive in this translation, (says the *Revue Encyclopedique,*) an incontestable proof of the progress of mathematics in the United States, a country which we are accustomed to consider as sterile in the sciences which are purely speculative. If all the divisions of human knowledge are there cultivated with as much success as this, learning will flow back towards its origin, and the west will shed its light upon the east. As the second volume of this translation is to appear in the course of the present year, we shall reserve our account of both until it arrives, and this will impose upon us new mathematical studies, for the indefatigable translator has more than doubled the extent of the original by his notes and commentaries, which will be more particularly the objects of our attention.—*Rev. Encyc. Mai*, 1830.

4. *Germination upon mercury.*—M. J. Pinot read to the Academy of Sciences, of Paris, a memoir, in which he certifies that a grain of *Lathyrus odatus*, after being steeped in water, was placed

on mercury covered with a very little water, that the germination proceeded as usual, and the radicle descended into the mercury to the depth of eight or ten lines. Having placed this grain in a state of suspension and equilibrium above the surface of the mercury, the radicle descended into the metal in the same manner, though the least resistance seemed as if it would disturb the equilibrium which maintained it.—*Bib. Univ. Avril*, 1830.

5. *Boring for Water.*—At the annual meeting of the Agricultural Society of Paris, April 15, 1830, after an appropriate discourse from the Ministers of the Interior who presided over the meeting, a memoir was read from *Hericart de Thury*, on the association (concours) for opening bored wells for the purpose of obtaining jets applicable to the wants of agriculture. He showed how rapidly this useful application of the miners' sound to the business of the well digger had spread not only in France but in every country of Europe. The programme of the society had been translated into Spanish, Italian, Dutch, Russian, Arabic, &c. and associations had been formed in many places for the acquisition of the requisite implements for boring, &c., and more than twenty departments are engaged in the enterprise.—*Rev. Encyc. Mai*, 1830.

6. *Preservation of iron from rust.*—A mastic or covering for this purpose, proposed by M. Zeni, and sanctioned by the Societé d'Encouragement, is as follows: eighty parts of pounded brick, passed through a silk sieve, are mixed with 20 parts of litharge; the whole is then rubbed up by the muller with linseed oil so as to form a thick paint, which may be diluted with spirits of turpentine; before it is applied the iron should be well cleaned.

From an experience of two years, upon locks exposed to the air, and watered daily with salt water, after being covered with two coats of this mastic, the good effects of it have been thoroughly proved.—*Bull. d'Encour. Jan.* 1830.

7. *Beet Sugar.*—The success of this branch of industry, in the North of France, leaves no doubt of its success in Belgium, the soil and climate of which are so favorable to the culture of beets. The rapid increase of the number of manufactories of indigenous sugar, in many parts of France, is a proof of the advantages which this new species of activity will afford to the country, and which doubtless will

acquire great extension, at no distant period. One of the principal manufacturers, M. Crespelle Delisse, of Arras, is of opinion that in ten years, France will gather from its own soil, the sugar necessary for its consumption and which is estimated at sixty millions of kilogrammes.—*Bib. Univ. Avril*, 1830.

8. *Hydrophobia.*—Three cases of the cure of this formidable disease, by friction with mercurial ointment, one of them at forty days after the bite, when slight symptoms of the disease, attended with spasms, had become manifested, are described in the Bib. Univ. Mars, 1830.

9. *Silicine.*—From the trials which have been made of this new febrifuge, at La Charité, by *M. Miguel*, and at l'Hotel-Dieu, by MM. *Hasson* and *Bally*, as well as by other physicians, it can no longer be doubted that M. Leroux has discovered, in the bark of the willow, a crystallizable principle, which possesses incontestably the properties of a febrifuge, in a degree which approaches very nearly to that of the sulphate of kinine, and this discovery is doubtless one of the most important that has for some years past been made in therapeutics.—*Rev. Encyc. Mai*, 1830.

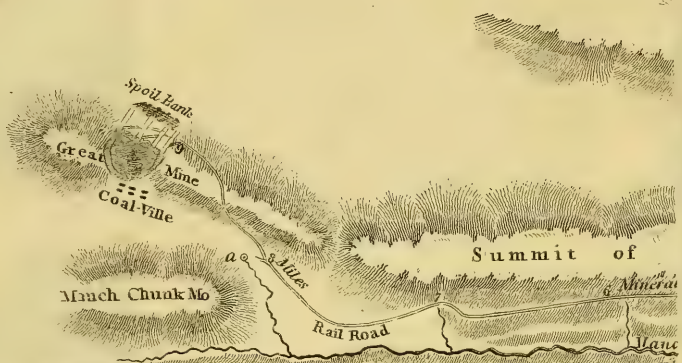
P. S. *Bedford Mineral Springs.*—A pamphlet, by Dr. William Church, containing an analysis of some of these springs, (described by Dr. H. H. Hayden, page 97 of the present number,) was received as the last proof was in the press. In a quart of the water of Anderson's or the principal spring, Dr. Church found 18½ cubic inches of carbonic acid gas.

Sulphate of magnesia or Epsom salts,	20. grs.
Sulphate of lime,	3.75
Muriate of soda,	2.50
Muriate of lime,	.75
Carbonate of iron,	1.25
Carbonate of lime,	2.
Loss,	.75
	31.00

Fletcher's, or the Upper Spring, gave rather more iron and common salt, less magnesia, and about the same proportion of the other substances.

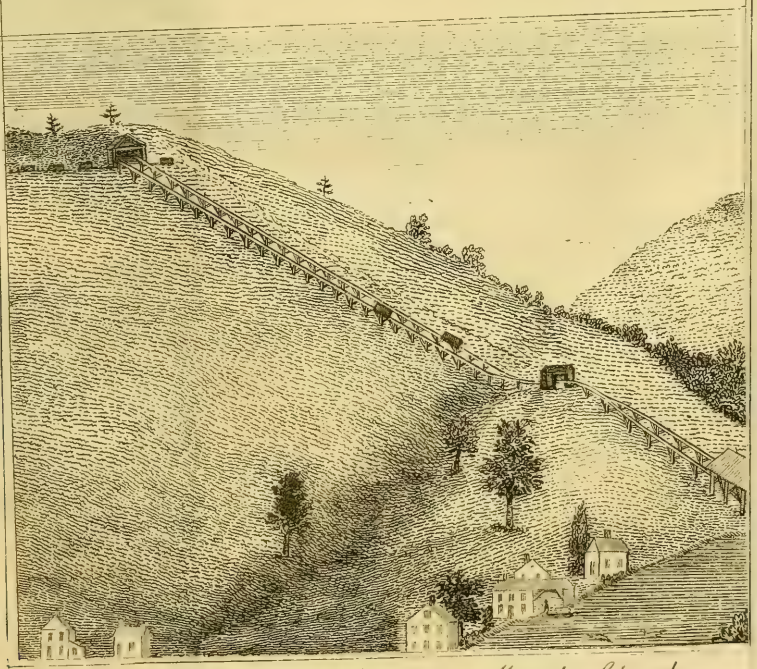
Shewing t

MAUCH



a Coal bed 60 ft in thickness
b Coal bed thickness unknown
c .. .. do do
d Coal bed abt 39. ft. in thickness Dip N^d
e .. .. 30. ft. thick ..
f .. .. 15 .. .. Dip N^d

The beds from b. to k. inclusive have been recently discovered & are not yet wrought it i



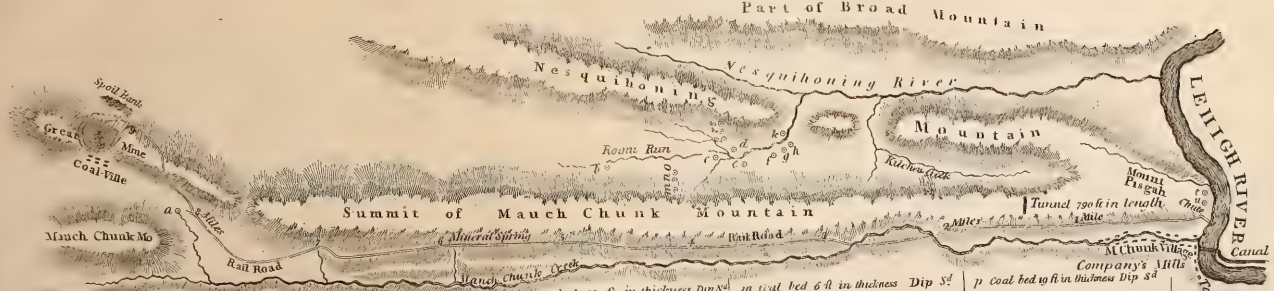
View of the Chute at Mauch Chunk.

MAP

Shewing the position of Coal beds now exposed

in the

MAUCH CHUNK COAL REGION.



a Coal bed 60 ft in thickness
b Coal bed thickness unknown
c .. .. do do

d Coal bed abt 39 ft in thickness Dip N.d
e .. .. 30 ft. thick ..
f .. .. 15 .. .. Dip N.d

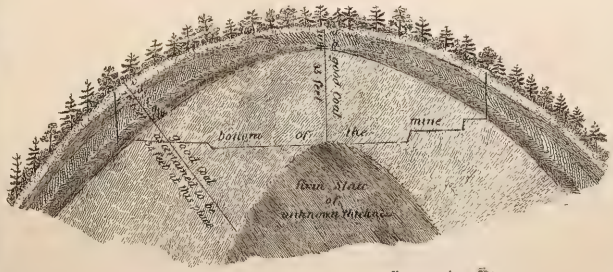
g Coal bed 15 ft in thickness Dip N.d
h .. 12 .. .. .. S.d
i .. 28 .. ..

m coal bed 6 ft in thickness Dip S.d
n 11 .. ..
o 20 .. ..

p Coal bed 19 ft in thickness Dip S.d
r .. 10 .. .. ..
s 5 .. .. ..
t 12 .. .. ..
u thickness unknown
also 2 more at Room run not marked each 5 ft

The beds from b. to k. inclusive have been recently discovered & are not yet wrought it is supposed that these beds extend without interruption to the great mine, which is near (by 5 miles distant

View of the Chute at Mauch Chunk.

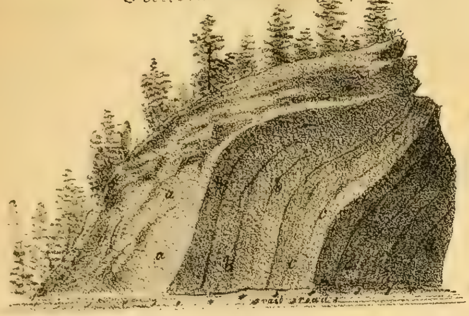


a yellow earth 1 ft.
b black earth & broken coal 9. ft.
c yellow earth 4. feet.
d grey wacke in fragments 4. ft.
e do .. large rocks 5. ft.
f dark earth (coal blossoms) 2. ft.
g fine rotten coal 1. ft.
h slate 1. ft.

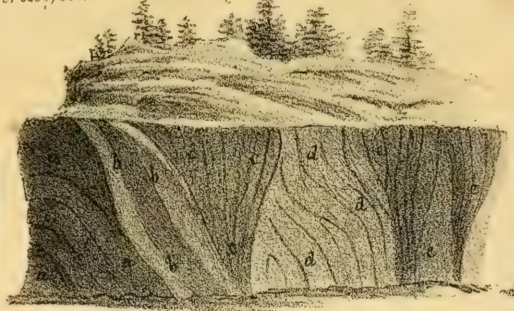
Imaginary Cross Section of the Mountain at the great Coal Mine

A. Doolittle sc

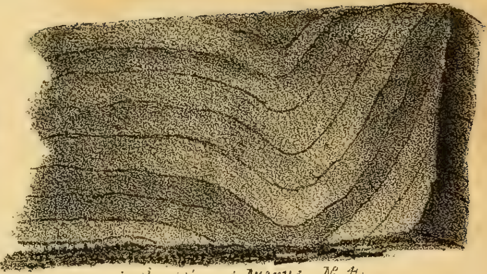
Sections exhibiting peculiar stratification in the great Mine at Mauch Chunk.



Vertical Section at Avenue No. 2.
a. earth & loose stones
b. gray wacke.
c. broken coal & earth
d. good coal.



Vertical Section near Avenue No. 3.
a. good coal.
b. broken coal.
c. Soft black slate.
d. Yellow slate.
e. pretty good coal.



Vertical section at Avenue No. 4.
This is good coal throughout, They have out into the mountain in spots ranging with this to an extent of 3 miles & find the stratification at all of them exactly similar.

Vertical section at W. side of Avenue No. 3
a. good coal.—b. slate & broken coal.—— c. yellow & black slate.
d. good coal.—e. gray wacke filled with numberless vesicles of various sizes.
f. broken gray wacke in laminae.—g. gray wacke firm & broken of very fine quality.
h. earth.

Vertical Section of a coal bed on the S. side of Nesquihoning Mountain;—marked E on the Mauch Chunk Map.
a. coal.—— b. a rock of graywacke imbedded in the coal.
c. graywacke.— d.—to e.—140 feet.— — f to—g. 92 feet.

on stone by Lehman; Drawn by George Jones.

Childs Lith.

t new species of Ulmus

Fig. 1. Inflorescence in an early state.
Fig. 2. The same more advanced, shewing the leaflets which frequently occur on the main pedunele.
Fig. 3. Leaf and branch with the corky excrescences.
Fig. 4. Outline of the leaf as seen on a plain.
Fig. 5. Fruit.

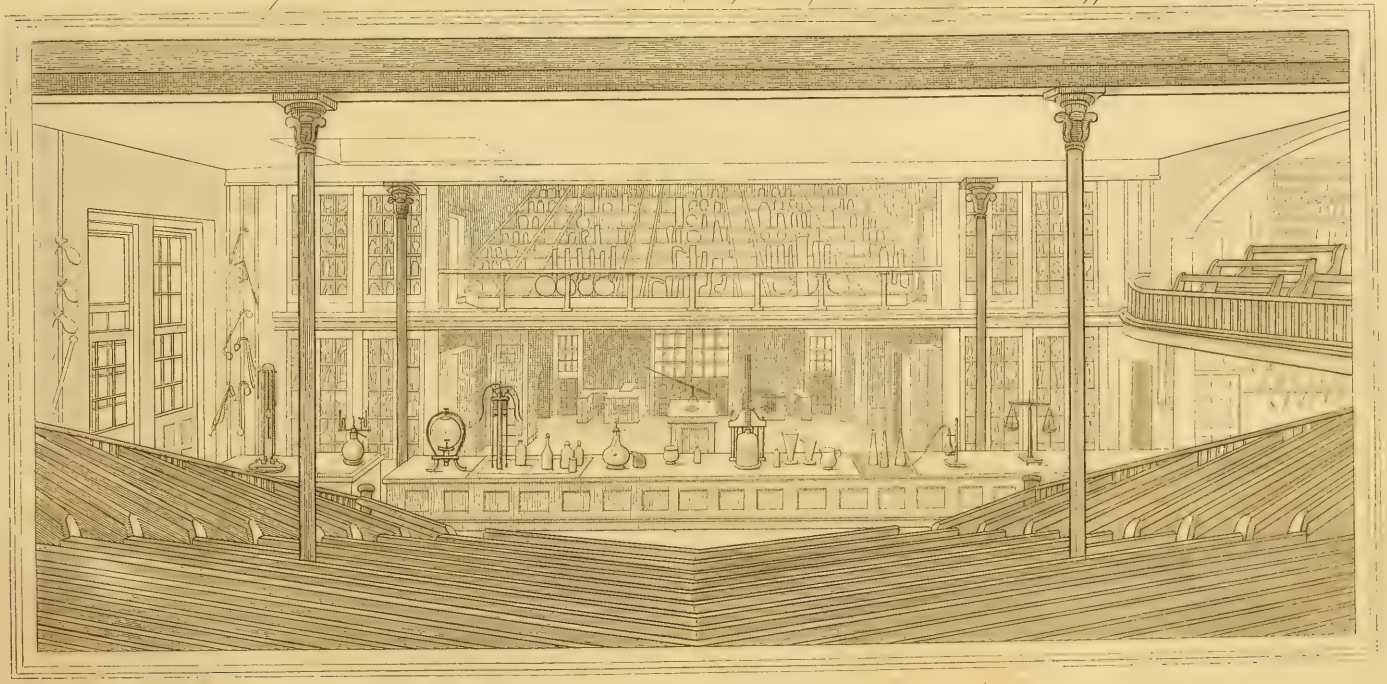
J. J. Thomas del.

See pa. 63.

Fig. 1. the Caterpillar State.
Fig. 2. the Male
Fig. 3. the Female.
Fig. 4. Shell of the Crysalis.

J. Doubleday sculp.

Interior view of the lecture room & laboratory in Medical Hall, showing apparatus &c. in use



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THE

AMERICAN

JOURNAL OF SCIENCE, &c.

ART. I.—*Experiments for acertaining the best method of obtaining and preserving Potassium; by* L. D. GALE, M. D. Assistant to the Professor of Chemistry in the College of Physicians and Surgeons, City of New York, Sept. 1830.

TO PROFESSOR SILLIMAN.

Dear Sir—I TAKE the liberty of sending you an account of a course of experiments made in the Laboratory of the College of Physicians, during the past spring and summer on the preparation of Potassium. My chief object in these experiments was, 1st. to acertain the best proportions of the materials to be used; 2d. the most economical receptacle for condensing the metallic vapor; 3d. the best means of preserving the metal so as to exhibit its high metallic lustre. The apparatus generally described in the books on Chemistry, is much too complicated and expensive to admit of general use: yet with the simplest apparatus, from the numerous sources of failure, no tyro in the profession I am confident, can manufacture potassium, without first serving an apprenticeship. Even the chemist who is well experienced in the more common manipulations, will often suffer the mortification of a complete failure, because he is not familiarly and practically acquainted with all the circumstances requisite to obtain success. Hence this metal though it may be afforded at a lower price than it now bears in the market, will probably never be sold, even at wholesale, for less than twelve or fifteen dollars the ounce. I made eight experiments in which three retorts were burnt through, six pounds of potassa consumed, and about four ounces of the metal obtained. During the first operation, Professor Torrey* was pres-

* I take this opportunity thus publicly to acknowledge my obligation to Professor Torrey, for the many useful hints given me on this occasion.

ent and directed the experiment. The remainder in consequence of his absence from the city, I was obliged to conduct without assistance.

Method of Preparing the Potassa.

The crude potash of commerce and pure lime in proportions, by weight of three of the former to one of the latter, are to be intimately mixed and lixiviated by means of pure rain water in a cylindrical iron or wooden vessel.* The apparatus which we constantly use in the Laboratory, is composed of a cylindrical copper vessel, about eighteen inches high and eight inches, internal diameter, tinned on the inside, and supplied with a small stop cock about half an inch from the bottom, and tube dipping down into the receiver below, which should have a narrow neck for the purpose of preventing, as far as practicable, the access of air, which it would afford carbonic acid to the alkali, and thus change it back to a carbonate. The best receptacle for the alkaline solution, is a large narrow necked bottle, the size of which must depend on the quantity to be lixiviated. The solution is to be transferred to a clean iron kettle and rapidly boiled to dryness; when the heat is to be raised to low redness, and the alkali kept in a state of fusion till the appearance of ebullition ceases, and the whole remains perfectly quiescent. It is now ready to pour into the retort, or it may be poured on a clean slab of marble, and immediately broken up and transferred to stopped bottles for future use.

Apparatus, &c. for the Experiment.

The apparatus necessary for obtaining potassium, consists essentially of a wind furnace with a good draught, a wrought iron retort capable of holding two or three quarts, and a large tube connected with the retort by a screw, and of sufficient length to project through the front of the furnace at least twelve inches. Charcoal is the only fuel I have been able to use with success. The retorts most economically fitted up, especially for those who live in the vicinity of large cities, are the common iron bottles in which quicksilver is imported. These

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* On account of its cheapness a wooden vessel is perhaps preferable. A small cask about the size of a common butter firkin, with a small hole bored and stop cock inserted, near the bottom, and dipping down into the mouth of the bottle for receiving the alkali, would form a very tolerable apparatus.

are made of malleable iron, of a cylindrical form, containing about a gallon and having an aperture at one end, closed by an iron plug by means of a screw one inch in diameter. In order to prepare it for use, the aperture must be bored out to receive a tube of at least an inch and a half internal diameter, and connected by a screw which accurately fits the bottle. If one much smaller than this be used, it is soon choked and the process is impeded or completely stopped. A convenient length for our furnace is sixteen inches. A more definite idea of the furnace and apparatus may be obtained from the figure on p. 212, which see. The lute for coating the retort, which after many trials, was found to answer the best purpose, is composed of equal parts of sand, pure clay and finely pulverized soapstone, mixed up with water into a paste and this, with a little cut tow to render it more adhesive, is applied in thin layers and each layer is dried in the sun; or if necessary it may be dried by a charcoal fire. This cement sustains the heat better than any I have tried. It adheres better when the retort is previously bound with iron wire.

Charging the retort, &c.

Although there is little doubt that Brunner's process of adding carbon to the iron turnings is preferable to any which preceded it, yet, not having had an opportunity of examining his original paper, I have been obliged to ascertain the best proportion of the ingredients by repeated experiments. It is found, when a large proportion of charcoal is used, that notwithstanding the metal sublimes at a lower temperature, yet so much charcoal in the state of fine powder is driven over with it, that the tube, unless much larger than the one described, would soon be choked. If too little charcoal is used, the high temperature required to decompose the potassa, would endanger the fusing of the retort, either of which would cause the experiment to fail. Hence the more charcoal is used in the process, the more capacity is required in the tube for condensing the vapors.

The result of my experiments is, that for a tube and retort of the size above mentioned, two ounces of pulverized charcoal, twelve ounces of potassa, and the retort filled up with clean iron turnings, or what I think still better, clean card teeth,* form the best proportion for the materi-

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* Damaged card teeth, which answer very well, can be obtained at a reasonable rate of the card manufacturers.

als. The receiver which was used in the first experiment, is the one described by M. Berzelius, a drawing of which may be seen in the eleventh edition of Henry's Chemistry, also in the Elements of Professor Silliman. It is composed of two cylindrical copper vessels, the upper one, which is smallest, is inverted into the lower one containing naphtha and in this the potassium is to be condensed. A hole of a sufficient size to receive the tube of the retort, is made in the upper portion of the receiver, also a small one for receiving a bent glass tube dipping down into quicksilver as a safety tube to discharge the uncondensed gases.

First experiment with the receiver.

The retort being placed in the furnace as seen in fig. 2. The fire of charcoal was lighted and soon a mixture of carburetted hydrogen and carbonic acid came over. A bent glass tube extending from the end of the iron tube, and dipping into a cup of quicksilver below, carried off the uncondensed gases. In about an hour the vapors of potassium appeared in the tube, when it was immediately wiped out clean and about a pound of naphtha was poured in the copper receiver above mentioned, which was then fitted upon the iron tube. The gas immediately made its appearance through the safety tube, and bubbled through the quicksilver. At this stage of the process, the great object is to keep up an uniform temperature; for the bottle being at a white heat or a very bright red, a slight variation either fuses the bottle, or prevents the potassium from coming over. The latter effect is produced even by throwing in fresh fuel; so that unless the fire be frequently fed by small charges of coal, the process is often checked. That the operation is going on well is known by the constant evolution of gas; if this be at any time suddenly stopped, it must probably arise either from the cooling of the retort, by throwing in fresh fuel, or from the choking of the tube, or the fusing of the retort. Whichever it may be, circumstances at the time will enable the operator to determine. If the tube be choked for the first time, it may be bored out by a suitable iron rod; but if it be the second or third time, we are generally obliged to throw down the grate and let the retort cool. In about an hour and a half from the time the potassium appeared distinctly in the tube, the latter was choked, when an iron rod prepared for the purpose was passed through the opening in the receiver quite into the retort, when, the obstruction being removed, the receiver was again attached to the tube. In fifteen minutes more the

tube became choked again, and having become impermeable to the iron rod; the grate was thrown down and the retort cooled. I was disappointed however on removing the receiver in finding little potassium in it, nearly all being condensed in the tube of the retort which had been kept cool by means of wet cloths. It immediately occurred to me that the circumstance of cooling the tube had prevented the vapor of the metal from passing into the receiver; accordingly I determined to obviate this supposed effect in the next experiment by letting the tube heat as much as it would, thinking by this means the metal would be condensed in the receiver. The second experiment was conducted in every respect like the first, except the circumstance of cooling the tube; and the result would I presume have been similar had not the retort been fused in the midst of the operation. This accident is the less surprising, as few bottles of the kind are thick enough to stand more than two operations.

The potassium obtained in the two operations was by no means the pure metal, but an alloy of carbon, potassium, and I think iron, though Berzelius states it to be carbon and potassium with potassa; that it contains iron I am sure from having obtained its oxide by decomposing the alloy in water; but whether chemically combined or not I am unable to determine. The alloy is not uniform in appearance, or in other properties. Some portions of it appear of a lead color, soft and malleable; others hard, brittle and of a grayish aspect, nearly resembling cast iron in its fresh fracture. This variety has the property of exploding with violence when suddenly struck with a hammer or rubbed briskly by means of an iron rod. There is a third variety which is the black powder; this, though it contains potassium, has less than either of the two other varieties; yet it will give the rose colored flame when thrown into water.

The alloy is detached from the tube, by first pouring in naphtha to protect it from the air; then by hammering the tube, the greatest part of the alloy is separated; the rest may be detached by means of an iron scraper, but much caution is necessary in using the scraper, lest the friction cause the compound to explode in the tube, as once occurred to me before I had learnt its detonating property. These accidents are completely prevented by keeping the alloy covered with naphtha. The product, when separated from the tube, ought to be distilled as soon as convenient, for much of it is oxidated by keeping it in that state for any length of time. Acertaining from the second experiment as well as from the first, that only a minute portion of the me-

tal was carried over into the receiver, it was evident that the expense of the receiver and naphtha could be dispensed with altogether; accordingly I performed all the succeeding experiments without them. I will give a detail of one as recorded at the time in the Journal of the Laboratory which is a pretty fair specimen of the others, except that the proportions of the materials in the retort were varied till I had ascertained that which was most successful.

Experiment without the Receiver.

The retort charged according to the preceding directions, was placed in the furnace as before, with the tube open to the atmosphere. At half past ten A. M. the fire was lighted; at half past eleven the retort was heated to a cherry red, as seen by looking through the tube. Gas, chiefly carburetted hydrogen and carbonic acid, come over in abundance. A quarter before twelve, gas was still constantly evolved, but in smaller quantities, and the metal began to sublime over, as indicated by the slight explosions which now commenced in the tube; this was immediately wiped out clean by a swab of tow on the end of an iron rod and closed temporarily by a perforated cork, having a bent glass tube dipping down into a cup of spirits of turpentine. This arrangement was adopted instead of the safety tube and cup of mercury, used in the former experiments. It now became desirable to be able to look through the tube, and examine the progress of the operation from time to time, without exposing the vapors to the action of the air. For this purpose, I took a cork which fitted the tube accurately, perforated it with a large hole, over one end fitted a plate of transparent mica, and confined it in its place by means of small tacks driven into the cork and made impermeable to gas by cement of plaster of Paris. On the side of the cork which projected, a small round hole was made for receiving a bent glass tube, dipping down into the cup of spirits of turpentine; through this the gases were allowed to pass. My chief reason for using the spirits of turpentine was its cheapness, the convenience of using it, and the very slight action which it has on the vapors. The quicksilver is soon covered with vapor of water, charcoal powder and various other foreign matters, which it is necessary to remove as fast as they collect, while the oil of turpentine requires no watching, the surface remains clear and even, and if the fluid should suddenly rush into the tube, as occasionally happens, little or no damage would result from

it. From a quarter before, until a quarter past twelve, the beautiful green vapors of potassium, resembling the dense flame of alcohol, tinged by copper, constantly filled the tube. From this time till one, the operation continued, but with less energy, and the vapor of the metal was less distinctly seen. At one, the tube was choked, as was indicated by the cessation of gas from the safety tube. The cork was instantly removed, and an iron rod one quarter of an inch in diameter forced through the tube into the retort; the gas again made its appearance, the cork was replaced and all went on as before till a quarter past one, when the tube was again full, and as the rod could not be easily forced through, the grate was dropped by pulling away its support with the hook *f* as seen in fig. 2. A clean cork accurately fitting the tube was applied and the whole left to cool; when this was accomplished, the alloy was removed and immediately distilled, yielding one ounce and ten grains of the metal.

Purification of the Potassium.

The alloy is to be put into an iron retort of a capacity just sufficient to contain it, having its tube a little inclined from a horizontal position, so that the metal as fast as reduced will run down and drop into the receptacle. The apparatus which I have used for the want of a better, and whose only defect is its small size, consists of a gun-barrel enlarged at the breech into a cup containing about a half pint. This is inserted in the furnace in the above mentioned position, with the tube projecting and kept at a temperature sufficient to preserve the metal in a fluid state, which may be done by supporting a wire cage of lighted charcoal beneath. The fire having been lighted in the furnace, and the retort heated to redness, the temperature should be kept up as long as any of the metal comes over.

Method of collecting and preserving the Potassium.

The French potassium, which has been thus far, almost the only kind sold in our shops, is put up in small globular masses weighing from a few grains to a half a drachm. This method causes a large surface of the metal to be exposed to the action of oxidizing agents, prevents its metallic lustre from being satisfactorily exhibited without removing it from the bottle into the air, and causes much of this valuable article to be wasted.

To remedy all these defects I caused the melted metal to drop from the end of the tube of the retort, (in which it is to be purified) directly into wide mouthed, ground stoppered vials. The metal so moulds itself to the surface of the glass, that it excludes all oxidizing agents and exhibits most beautifully and fairly its high metallic lustre, which cannot be distinguished from that of the purest quicksilver. According to the above description I have prepared a number of bottles, which not only exhibit the true metallic lustre, but preserve the metal as long as required. The only portion which can possibly be oxidized is the upper surface, and this is protected by a thin film of naphtha or oil of copaiva. The above article is put up in bottles holding from half a drachm to two drachms, and is now for sale by Mr. Geo. Chilton of this city.

Fig. 1.

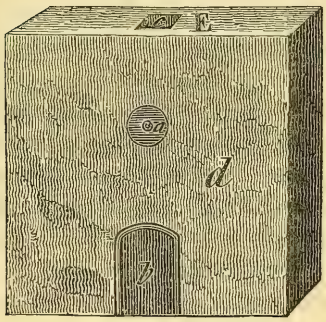
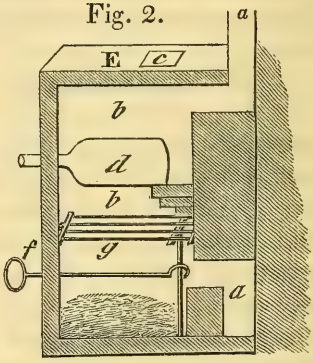


Fig. 2.



In fig. 1, is represented a front view of the furnace, in which *a* represents a circular hole for putting the retort and tube into the furnace which is closed by a piece of soap stone, fitted accurately and perforated for receiving the tube of the retort; *b* the door of the furnace used for removing the ashes and passing in the fire hook to pull down the grate; *c* the aperture on the top for throwing in fuel; *d* the front of the furnace, and E the top.

Fig. 2, represents a side view of a section of the furnace; *a a* is the passage for the air which comes from the cellar; *b b* the interior of the furnace; *c* aperture at the top; *d* the retort and tube, the latter passing through the hole *a*, seen in fig. 1. The retort rests on bricks which project from the back of the furnace; *g* is the moveable grate, one end resting on a projection from the walls of the furnace, while the other is supported by bricks pulled down with the hook *f*, whenever necessary.

ART. II.—*Instructions for the benefit of those, who are engaged in collecting Insects for cabinets of Natural History; by* M. THEODORE ROGER. *Translated for the American Journal of Science, from the first volume of the Bulletin d'Histoire Naturelle de la Société Linnéenne de Bordeaux; by* JACOB PORTER.

General Rules.

THE object of an entomologist being to become acquainted with all the species of insects, that may exist, it is necessary that he should be on his guard against the prejudice, that very naturally leads one to consider as the most valuable the insect, that is of a large and singular form and brilliant color.

The mountains nourish insects, the greater part of which differ from those of the surrounding plains. Soils of a different nature produce likewise different species. Whoever, therefore, would collect the greatest possible number of insects in a country, must be at the pains of exploring, for this purpose, all situations from the most arid, to those, that are covered with the richest vegetation. It is, however, to be observed, that in these last he will find a far greater number of species, and, in general, these species are far more abundant. To these places it will, therefore, be necessary to direct his researches the oftener.

The manners and habits of insects are also very various. Some adhere to flowers; others live on the trunks of trees, or under their bark, more particularly, the bark of old trees, that are decayed and rotten; certain species are found on stones, and in the earth at the foot of trees, especially in moist places, that border on rivulets and stagnant waters.

There are, besides, multitudes, that live in manure, in mold, in rubbish, and in the remains of vegetables and animals in a state of putrefaction; some species live in mushrooms; finally, stagnant waters nourish them in very great numbers.

Insects are generally so fragile that they are very easily injured when taken. Nevertheless, in order to facilitate their classification in a collection, it is indispensable that they should be entire, and that their colors should not be effaced; for the characters, that serve to assign them their place, are always derived from the form of their claws, that of their feelers, the number of articulations in their tarsi,

and lastly, from their colors. Now these being precisely the things, that are most liable to be destroyed or altered, a collector cannot use too much precaution in taking an insect. The butterflies, of all others, are those, that require the greatest address. The extreme fragility of their wings, and the slight adherence of the colors, that decorate them, expose the pursuer to break them, if he handles them too roughly, and to discolor them, if he touches the wings with his fingers.

I will add, lastly, that he, who would make an object of speculation of the avails of his researches, will find his hopes defeated if his insects are not well preserved. The more the admirers of collections increase, the more scrupulous do they become with respect to the perfect preservation of the insects, that they wish to purchase. Those, that are injured, will not sell at any price.

Instruments of Pursuit.

A collector should be furnished with the following utensils :—

1. A net of gauze;
2. Rackets in gauze;
3. An umbrella;
4. A small trowel;
5. A bownet of horse hair or canvas;
6. A tin box;
7. A wooden box lined with cork;
8. A certain quantity of triangles of paper;
9. Pins of several sizes;
10. Bottles with large necks.

1. The net is formed of a piece of large iron wire bent into a circle of nine inches in diameter, and the united ends of which are fixed in a socket of tin. This socket should be three inches long. It should be a little conical in form so that a handle, which may be longer or shorter, may be fastened into it. To the wire circle are attached the extremities of the gauze net, which should be twenty inches long.

This net answers for taking, while on the wing, all sorts of insects, and, more particularly, the butterflies. It may also be used in another manner, which consists in passing it over the summits of flexible plants, such as the large herbs of the meadows. The insects resting on these plants fall to the bottom of the net, and, in this way, the pursuer finds a great number of small species, that would otherwise escape his notice.

2. The rackets may be compared to the pinchers used by surgeons, or to scissors, each half of which should be terminated by a rhomb covered with gauze, drawn tight over it, so that on shutting the pinchers, the two rhombs may perfectly fit each other.

This instrument, the most useful for the taking of insects, is that, which requires the greatest address. It is only by long continued practice that one acquires the habit of using it with success. An unskilful collector will often tear the gauze, and oftener still miss the insect, that he wishes to take, though it should be at rest. But if the rackets have this inconvenience at first, they will, when one has learned to handle them skilfully, have great advantages over the net. First, a butterfly taken in the rackets will never be injured, since, on being pressed between the two pieces of gauze, it cannot struggle. Secondly, the pursuer, by means of them, will have nothing to fear from certain insects, such as wasps, bees and hornets, from which he could not avoid very painful stings, should he venture to seize them with his fingers.

3. The umbrella, (or, for want of it, a cloth,) is used in the following manner. On being held under trees, shrubs or bushy plants, and striking with a stick the branches, that are over it, all the insects, that are on the branches, fall into the umbrella. One may find, by this means, many species, which, flying only by night, remain concealed during the day.

4. The trowel, which is perfectly similar to those used by bricklayers, serves for digging at the roots of trees, for lifting up their bark, and for searching in rubbish. One may find, in this way, many of the coleopterous insects and of the chrysalides.

5. The bownet is made like the net before mentioned, except that the iron wire, instead of being bent into a circle, should have the form of a shovel, the right side of which should be opposite to the socket. The net, with which the wire is furnished, should be of horse hair or canvas, and six inches in length.

In collecting with the bownet, one should pass it among the aquatic plants, lifting up those, that are at the surface of the water. The water runs off, and among the plants, that remain in the net, there are often found many insects.

6. The tin box should have the form of a large snuff box. In the center of the cover should be a hole, large enough to admit an insect of middling size; (a melolontha or May bug, for instance.) This hole may be opened or shut at pleasure, by means of a little

plate of tin, which should move round on the cover, being fixed at only one point, around which it is moveable.

This box is to be half filled with sawdust, on which should be turned some drops of the essence of turpentine. This being merely to give a strong odor to the box, it should not be turned on in sufficient quantity to make the sawdust glutinous. The sawdust should have been previously passed through a large sieve, to cleanse it from all the powder, that it might contain; that only to be used, which remains in the sieve.

7. The wooden box, (or, it may be of pasteboard,) should also be portable. It may have the form of an octavo volume, and should be about two inches in thickness. The bottom is to be lined with cork, or, for want of it, with a substance sufficiently tender to be easily penetrated by a pin, as the pith of elder or of certain plants from warm countries. Pure wax may also be used in the same way, which it is necessary to melt and mix with a certain quantity of the oil of turpentine, as the wax alone would be too dry and brittle.

It is necessary that the cork should be fine, and that it should be, at least, two lines and a half in thickness. The wax having more tenacity, a layer from a line and a half to two lines thick will be sufficient. The pith, on the contrary, retaining the pins with less strength, should be thicker.

8. The triangles of paper being intended principally for containing the butterflies, it will be well to have them of several sizes. They are prepared in this way: The paper is first cut into squares, which are folded diagonally; then one of the little sides of the triangle is closed by a double fold. The third side is left open till a butterfly is put into the triangle. If, instead of folding over the little sides, they should be closed with paste, it would be still better.

It would be well to be furnished with a box with two compartments, one of which may contain the triangles, in which the butterflies are placed, and the other the empty triangles.

In order to secure the butterflies from destructive insects, that easily pierce the paper, it is very desirable that the sheets, before making the triangles, should be dipped into a saturated solution of alum.

9. The pins to be used for insects should be of different sizes. It is necessary that they should be very fine. Their length should be, at least, from twelve to fourteen lines. They are known among the merchants by the name of lace pins. It is well to be furnished with a ball, into which they may be stuck, separating the different

sizes, so as not to be obliged to search long for that, which is suitable for the insect caught. It will be readily seen that to pin a small fly one must not use so large a pin as would be necessary for pinning a horned beetle. It is degrading an insect to fasten it with too large a pin.

Manner of taking the Insects.

The coleopterous insects not being poisonous at all, one may take them with the hand without incurring any risk. Some large species, however, are armed with strong mandibles, by means of which they might pinch the one, that takes them. But if he has the precaution to seize them with two fingers by both sides of the body near the origin of the elytra, he has really nothing to fear. The coleopters, for the most part, fly little; it is very difficult to take them on the wing, though they may be taken, at other times, without the aid of the net or rackets. Indeed, few species require the use of these instruments.

The orthopterous tribe, like the preceding, are not poisonous. One may, therefore, touch them with impunity. But as they fly with great facility, and are almost all endowed with the faculty of leaping to great distances, it is necessary to make use of the net or rackets to take them. The grasshoppers, crickets and the like are so well known, that it is needless for me to say more respecting them.

The neuropters, (that is, those with nerved wings,) fly still better than the preceding; and they are destitute of all poison. If one cannot come at them with the rackets, they may be taken with the net when they are at rest.

The hymenopters, (bees, wasps and the like,) are, for the most part, poisonous. It is from the extremity of their abdomen that they dart their deleterious sting, that causes deep wounds, almost always followed by inflammation, sharp pain, and sometimes with an ague fit. Their abdomen is attached to the lower extremity of the corselet by a longer or shorter pedicel in form of a thread. It is so movable that they can throw round their extremity to all parts of the body. One must, therefore, be on his guard against taking them with his fingers.

The species of hymenopters, whose abdomen, little moveable, is united to the corselet in its whole size, are not poisonous. These are easily known.

The hemipterous order does not afford any poisonous species; but they are almost all armed with a long beak, and some have it so sharp and hard that they can make very painful punctures. I would advise the pursuer to take them with the rackets, rather than with his fingers.

They exhale, besides, a disagreeable odor not unlike that of bed-bugs, whence they have received, among the common people, the name of wood bugs, garden bugs and the like.

The lepidopters, that is to say, the butterflies, whether of the day or night, need not inspire the pursuer with any fear; but it is so easy to tear or discolor them, that they must not be seized with the fingers. If they are flying, they may be taken with the net. If they are at rest and can be easily approached, the rackets are to be preferred, in which they cannot flutter. The butterflies of the night begin to appear an hour and a half after sunset. The honeysuckle, lilac, night willow herb, the great nightshades and soapwort are the plants in the garden, which they prefer, and around which they may be seen fluttering in great numbers when the evenings are fine. In the fields it is on the valerians, the laurel of saint Anthony, viper's bugloss and the like that they are found. This pursuit, taking place only in the twilight, continues little more than half an hour. If they fly longer, it is necessary to be provided with a lantern, which serves not only for discovering the butterflies, but likewise for attracting them.

The collector will sometimes find the night butterflies adhering to the walls, the trunks of trees and the borders of roofs. These species are so torpid that they may be approached without disturbing them in the least. The best method of taking them is to fasten them with a pin passing through their corselet, and, in this case, there is no need of pressing them, as they do not often revive and flutter their wings, even when taken from the place where they were resting.

An excellent method of procuring the butterflies in a state of perfect preservation, is to raise them from the caterpillars. Whoever takes the trouble of doing it, will be amply compensated by the curious, instructive and amusing observations, that he would have occasion to make. He should, for this purpose, take the different species of caterpillars, that he finds in his rambles. They should be collected in a wooden box about the size of that before mentioned, into which should be put some small branches of the plants, on which the caterpillars are found. On returning home, they should be put into a large box, the sides of which, instead of being of wood,

should be of gauze. As many species of caterpillars enter the ground to be there transformed into the chrysalis state, it is necessary that there should be, at the bottom of the box, a bed of light earth two or three inches in thickness. That the caterpillars may not perish for want of nourishment, they must be furnished with fresh plants. It will not be necessary to change the plants often, if one has the precaution to put the stalks into a vessel full of water, according to the practice of preserving, for several days, flowers in a room. The vessel should be placed in the middle of the box, and closed by a cover perforated with holes. These holes being stopped by the stalks, the caterpillars cannot drown themselves, as would often happen, should the vessel be uncovered. The caterpillars, after arriving at their full growth, will form their chrysalis, and, in a longer or shorter time, the butterflies will appear.

It is necessary to avoid handling the chrysalides, as it will tend to destroy them.

One may put into the box the chrysalides taken in his rambles, either by means of the trowel or in any other way. A chrysalis, that is injured, should be thrown away, as it will never revive.

The lepidopters, whose caterpillars are suspended before their transformation, commonly hatch at the end of fifteen days at the least, or thirty days at the most.

The caterpillars, that inclose themselves in a cocoon, remain a longer time in the chrysalis. Generally the consistence of the cocoon is proportioned to the continuance of the time, which is very variable. There are some lepidopters, that hatch at the end of a month; others in two or three months; and some, that continue a year or more in the chrysalis. The species, that go into the earth, remain there from a month to a year.

I will not close this article without warning the collector against the prejudices of infancy, which might inspire him with disgust and even horror at the caterpillars. They are no more dangerous than the butterflies, that proceed from them. Nevertheless, should he meet in the woods, and particularly at the root of oaks, with those large nests of caterpillars full of dried skins, he must approach them with caution. The hairs, which the wind might blow on his skin, would occasion painful itchings.

The dipters, (of which the flies form a part,) are not in the least dangerous. They may all be seized with the hands; but, as they are very active, it is scarcely possible to take them without recourse to the net or the rackets.

Art. III.—*Essay on the Mineralogy and Geology of St. Lawrence County, State of New York; by* J. Finch, F. B. S., &c.

The northern part of the State of New York, bordering on the river St. Lawrence, has rarely attracted the notice of the mineralogist.

I was invited by Jacob A. Vanden Heuvel, Esq. during the summer of 1830, to pass a few weeks at his residence at Heuvel, a flourishing village near Ogdensburg, and took advantage of the opportunity to make some excursions in the vicinity. The result has been the discovery of some new localities of minerals, which may be interesting to those who are pursuing that department of natural science. Among the bowlders scattered over the surface of the fields, there may be observed, granite, porphyritic granite, and gneiss. They have their angles rounded, but are not of very large size. Most of these differ in general character and appearance, from the primitive rocks found at the south of the county, and we must therefore refer their origin to the rocks of Canada. At Laurentia, the seat of Mr. Vanden Heuvel on the St. Lawrence, there are numerous massy bowlders, composed of Labrador felspar, hornblende, and glassy felspar, thus forming a rock which has not, I believe, been found in any other part of the United States. Masses of sandstone, and transition quartz rock, also occur on the surface, but their angles are not rounded, and they are evidently derived from the immediate neighborhood. Among the few minerals which occur in the loose bowlders are pargasite, augite and resplendent hornblende.

The formation at Heuvel, which also extends across the whole of the County, is granular quartz rock, composed of grains of quartz, cemented by decomposing felspar. A small quantity of alumine is sometimes united to the quartz. It is usually of a grayish white color, sometimes reddish white. Occasionally it is full of small cavities, which give the rock an honey comb appearance. It occurs in strata, varying in thickness from a few inches, to two feet. It lies nearly horizontal, the inclination in no instance near Heuvel, being so much as 10°. Sometimes the rock is covered with very minute crystals of pure quartz. This formation must be referred to the transition series, on account of its horizontal position,* and because in

* An indecisive character.—*Editor.*

some instances it alternates with transition limestone. In some loose rocks of the same kind I have observed fossil tubipora and madrepora.

As this transition sandstone does not undergo decomposition, wherever it approaches too near the surface of the ground, it is unfavorable to vegetation. Instances of this are rather numerous in some parts of the country. One mile west of the village, this rock forms the surface of near two hundred acres. It is called the Flat Rock of Heuvel. In ancient time there was apparently little or no superficial soil upon it, yet the Lichen geographicus fixed its habitation there. It has in many places been succeeded or accompanied by the Lichen rangiferinus, and one or two other varieties of mosses. Never in any other situation have I seen them growing in such luxuriance. They sometimes cover a space of two hundred square yards without the intervention of any other plant, and as they are quite undisturbed, form a verdant carpet from six to nine inches deep on the surface of the rock. The decomposition of the mosses, has produced a small quantity of soil in the crevices; the pine, fir and oak grow there, but never attain the size of the trees in the neighboring forest. As they cannot strike their roots deep in the ground, they are easily torn up by the wind.

In many places the rock is quite bare of vegetation; the contrast between its white surface and the green foliage of the pine, is very remarkable.

The road between the villages of Heuvel and De Peyster passes over this formation, but such is its extreme hardness, that the wheels of the carriages have not made the slightest impression. If portions of this rock sufficiently large, could be transported to a distance, and deposited in places where rail roads were required, it would completely answer the purpose, with the advantage that the carriages need not be confined to any particular track.

Ogdensburg, the chief town of the county of St. Lawrence, is built on diluvial soil, covering a formation of siliceous limestone. This limestone may be seen in a quarry, at the western extremity of the bridge over the river Oswegatchie. It is extremely impure. It occurs in layers of various thickness, from four inches to twelve. The superior strata, are of a yellow brown color, and contain so much silex and alumine, as to be unfit for making lime. Two miles from Ogdensburg, near the seat of Mr. Copeland, the limestone forms a hill rather elevated.

In the sand bank, on the borders of the Oswegatchie, and in the town of Ogdensburg, there have been occasionally dug up pieces of Galena. One of them weighed sixteen pounds; it was apparently rounded by attrition, and had no mark of having been recently brought from a vein. There is however a tradition in the country, that the Indians knew of a mine of Galena; it is certain they had a plentiful supply.

Proceeding with Mr. Vanden Heuvel on a tour to Rossie, we rode along the north shore of Black Lake. At Judge Davies' residence we observed the quartz rock to alternate with limestone; the latter was said to be of excellent quality. A few miles beyond, opposite the narrows of the lake, the quartz formation appears on the surface, and barrenness is the invariable result. Sometimes a slight inclination is visible in the strata. The road from the border of the lake towards Hammond, passes along the edge of the quartz formation for several miles. It presents a very interesting appearance, forming a mural precipice. This has an elevation of near eighty feet, but fragments of the rock falling from time to time, have produced a pile of ruins along its foot, and have thus reduced its apparent height. The formation terminates abruptly, and from the extensive plateau formed by the horizontal strata of the quartz rock, we look over the tops of the forest trees which grow in the valley beneath.

One mile from Hammond, on the road to Rossie, we descended from the quartz formation and arrived at a swamp, over which a causeway has been made. Passing over this causeway we arrived at primitive rocks. The range to which these belong, passes through the whole county of St. Lawrence from east to west and is about twenty miles wide. It crosses the river St. Lawrence at Chippeway bay, and at Alexandria, and appears in Canada near Kingston. The rocks of that vicinity have been described by Lt. Bonnycastle, R. E.*

The first primitive rocks, which I saw two miles from Hammond, very much resemble those of Malvern in England, which I had an opportunity of examining a few years ago. They are chiefly composed of quartz, felspar and hornblende. Near the causeway, felspar and quartz occur, variously aggregated, the former predominates; sometimes flesh red, occasionally dark brown red, and sometimes much intermixed and colored by epidote. Seams of this mineral occur in the rock, but it is rarely crystallized. Proceeding to-

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* See Vol. xvii, p. 85 of this Journal.

wards Rossie, the hornblende is the chief ingredient in the rock, sometimes mixed with felspar, or with quartz; sometimes with both.

The rock is usually slaty, and may generally be called Hornblende Slate. The stratification runs nearly east and west. The strata are frequently contorted, sometimes twisted in all directions. An instance of this may be seen twenty yards north of the village of Rossie.

Small veins of granite traverse the hornblende slate. Mica scarcely occurs, and its nearly total absence, forms a striking feature in this range wherever it has been examined.

This part of the chain of primitive rocks near Rossie, forms a range of hills which are usually a quarter of a mile across, and divided from each other by valleys of greater or less breadth. The hills have an elevation of about one hundred and fifty feet, but as the sides are steep, and the road crosses nearly at right angles, it makes travelling very difficult.

Four miles from Hammond there is a ledge of dolomite, or coarse granular magnesian carbonate of lime. It is greyish white, and contains small plates of yellow mica, and particles of graphite. We also observed crystals of white augite, but they were on the surface of the rock, and much weathered.

The village of Rossie is situated in a valley on the Indian river. There are extensive iron works, owned by Geo. Parrish, Esqr. but they are not at present in operation. I saw specimens of iron ore on the bank, but as I afterwards visited the mine, shall hereafter notice the varieties.

In a field, a quarter of a mile east of the iron works, is a bed of white limestone; it contains condrodite, disseminated in grains through the whole rock; color bright yellow, brown yellow, and green. Phosphate of lime in small sky blue crystals. Brown mica. Fluate of lime, purple color, in calcareous spar. Automalite or spinelle zincifere in minute octohedral crystals.

An attempt was made to use this limestone as a flux in the iron ore furnace, but the infusibility of the condrodite, rendered it quite refractory. The stone used in lining the furnace, was transition quartz rock.

In several of the hills near Rossie, small veins of schorl occur in the granitic rocks, it is not well crystallized. Magnetic iron ore is found three miles to the west, and one mile from Indian river. It is said to be abundant. Continued showers of rain, and more inviting objects of inquiry prevented a visit to the locality. It is probable

that iron ore abounds in several parts of this range of primitive rocks, and if the iron works of Rossie should be resumed, the expense of procuring ore would probably be much less than was formerly incurred.

At Judge Streeter's farm in the town of Rossie, two miles from Oxbow, the following minerals occur. White limestone, extending over two hundred acres. It is quarried, but not advantageously, as only the blocks near the surface of the ground are obtained. Glassy tremolite. Graphite in small plates. Coccolite. White augite in imperfect crystals. Zoisite, of this mineral I found only one specimen in a stone wall.

The mine from which the iron works of Rossie were supplied with ore, is situated one mile south of the road between Antwerp and Gouverneur, at a distance of seven miles south west from the latter village. The following minerals may be obtained.

1. Red iron froth. This occurs massive, but usually forms a coating to the other varieties of ore. It has sometimes been mixed with oil, and used as a paint; it has then a purple tint, very pleasing to the eye. At Rossie it has been applied to some buildings, and the color is very durable. This species of iron ore stains very strongly. The sheep of the vicinity are partial to lying in the mine, and their fleece becomes stained of a deep red. It is said to be difficult to free their wool from this color. They exhibit the singular appearance of a flock of red sheep. A man who was formerly employed in the mine, said that the clothes of the workmen were dyed in a similar way.

2. Micaceous specular iron; called black lead by the miners. In thin layers, sometimes lining small cavities. It is composed of thin laminæ, or scales of shining metallic lustre; color bluish black.

3. Compact protoxide of iron.

4. Red oxide of iron.

5. Spathose iron ore, in small quantities.

6. Iron flint or Eisen Kiesel; of a dull red color; excessively hard. Mixed with the other varieties of ore; sometimes so abundant as to cause great labor to the miners. It requires to be carefully separated.

7. Sulphuret of iron, disseminated in some parts of the rock, which then becomes of a dark yellowish brown color. Water passing over it decomposes the pyrites, and there is formed,

8. Sulphate of iron.

9. Ochre yellow, very impure.

10. Ferruginous quartz; purple tint, similar to that variety called Bristol diamonds; occurs in cavities in the ore.

The side of the hill where the mine is situated, has been opened to a depth of forty feet. Many thousand tons of iron ore, were obtained from this mine, when the works at Rossie were in operation, and the quantity is apparently inexhaustible. It has also been traced to a distance on the north west, and a quantity of ore obtained.

One mile south west of Gouverneur village, large rocks of felspar and quartz may be noticed on the side of the road. At this locality I discovered phosphate of lime; one hexagonal prism, three inches long and one inch in diameter. Quartz crystals, four inches long, one inch in diameter; in carbonate of lime, but not very perfect. Calcareous spar, white and red. Magnesian carbonate of lime. White augite. Scapolite, massive. Augite, in small crystals, well characterized. Coccolite, dark green. Graphite and silvery mica. Tourmaline, brownish red, in crystals two inches in diameter.

At Gouverneur village, the bridge across the Oswegatchie river, which is distinguished by the blackness of its waters, rests on a pier of solid rock. The breakwater to this pier contains crystallized serpentine and calcareous spar. It would however be difficult to obtain specimens, as the inhabitants of the village would probably be unwilling that the bridge should be endangered merely to gratify the wishes of a mineralogist.

On the east bank of the river, near the mill, a quarry has been opened; it contains the following minerals. Argentine. Serpentine, disseminated in carbonate of lime. Coccolite, dark green. Magnesite. Asbestos.

For the following localities, I am indebted to Dr. Murdoch of Gouverneur. A petrifying spring occurs four miles north west of the village; the water which flows from it, covers the grass, moss and roots in the vicinity, with carbonate of lime. Agaric mineral is found two miles north of the village. Steatite, brownish black, on the farm of C. Barrell. Calcareous spar, in laminated masses, two miles north east of the village.

In the town of De Kalb, quartz rock forms an extensive district of country. White limestone is quarried and burnt into lime, one mile north of the village near the mill.

On a second tour from Heuvel to the east and south of the county of St. Lawrence, I noticed the following facts:—Silicious limestone,

forms the greater part of the townships of Lisbon, Madrid, Louisville, Norfolk and Massena; also the northern districts of Potsdam and Stockholm. Near the river St. Lawrence, the country is usually level; at a distance of ten miles, it exhibits a fine undulating surface; at fifteen miles it becomes hilly.

The rapids of the St. Lawrence, commence at the red mills, seven miles below Ogdensburg; the river there flows over limestone.

One mile from Massena, on the banks of the river Racket, is a mineral spring, from the bottom of which, bubbles of sulphureted hydrogen gas continually rise. The water is strongly impregnated with the gas, and its peculiar smell, may be distinguished at some distance. A deposition of sulphur takes place on the stones of the well. The waters of this spring, appear to resemble in their general qualities, those of Harrowgate in England. Hitherto few persons have visited this spring, as there were no accommodations for visitors. A large boarding house has been recently erected, and it begins to attract notice.

Mineral springs of a similar kind have been noticed in other situations, on the banks of the same river, but this is more strongly impregnated than any hitherto discovered.

At Norfolk I visited the furnace, where cast iron is made during the winter season. They use bog ore which is brought from some distance. It is classed into three kinds—Loam ore, Shot ore, Pan ore; varieties which arise merely from the state of aggregation. At a forge in the same village, where bar iron is made, they mix a proportion of the protoxide of iron, called Mountain ore, with the varieties mentioned above. The mountain ore, which is brought from Malone, contains some very fine octohedral crystals.

At the village of Potsdam, a low range of primitive rocks crosses the river, and forms a series of falls and rapids, which are very advantageous for mill seats. The rocks exhibited here are a red colored granite, containing very little mica, and hornblende slate. An excavation has been made in the latter rock near the bridge, and we there observed the following varieties of minerals. Resplendent Hornblende in large crystals. Talc. Sahlite, light green, not abundant. Scapolite, grey. Quartz, brown, yellow, and reddish. Felspar, greenish. Micaceous iron ore, and copper pyrites, in minute particles.

Two miles south of Potsdam, quarries of sandstone have been opened on both shores of the river: we visited that on the east. It

is difficult of access as the road passes for some distance in the bed of the river. This quarry is of particular interest. The sandstone is of the same structure as the rock of Heuvel, which is abundant in the county, but it is tinged of a faint reddish hue by oxide of iron, and that rather unequally. The quartz is colored more than the felspar. Hence the composition of the rock is more easily observed. It resembles precisely, the rock of Bromsgrove Lickey in Worcestershire, England, which has been described by Prof. Buckland in the Geological Transactions. A similar rock is found in the vicinity of Reading, Pennsylvania.

Many private houses at Potsdam are built of this species of stone, and from the regularity of the layers, and the color, they have a pleasing appearance.

Seven miles from Potsdam, on the road to Pierrepont, is a rock of Serpentine, of a reddish color. Magnesite and talc.

Eight miles from Potsdam, on the same road, is a fine locality of minerals. Large masses of primitive rocks are scattered on the adjoining fields, and we there noticed, Granite, composed of adularia, red felspar, gray quartz and black mica. Granite, composed of white felspar, reddish felspar and tourmaline. Brown quartz. Tourmaline in crystals, three inches in diameter. Augite in trap rock. Felspar in crystals twelve inches in diameter, in granite. Black mica in plates seven inches long.

The masses of rock in which these occur appear not to have been brought from a great distance; the angles were not much rounded. From Pierrepont to Russel, we travelled the whole distance over primitive rocks. At Pierrepont, near the summit of the hill, I observed brown quartz, fluor spar. One mile north of Russel, four hundred yards from the road, is a locality of steatite, grayish white, brown, much intermixed with quartz. Tremolite, inferior specimens. Indurated talc. On a hill to the south west of the village, is a quarry of white limestone, it contains augite, minute crystals, reddish laminated calc spar.

Opposite the quarry, near a farm house on the road, is a vein of sulphuret of iron, much intermixed with black slate, which has been mistaken by the inhabitants for coal.

At Allen's mills on the Oswegatchie, there are two hills which would probably yield many varieties of minerals if they were thoroughly examined. Our stay there was short, yet we found white augite in very perfect crystals two inches long, and seven eighths in

diameter, in carbonate of lime. Augite, yellowish brown. White hornblende in crystals terminated at each end. They are usually small, some of them are one inch long by three eighths in diameter. Noble serpentine, massive or intermixed with limestone. Noble serpentine in small grains in calcareous spar.

One mile beyond Allen's mill there is a hill of red felspar intermixed with minute particles of quartz. The intensity of color of this rock would cause it to be distinguished by any traveller. It divides into small fragments of indeterminate size. Although the lines of separation are visible on the surface of the rock, it requires some exertion of force to detach them.

One mile from Little York, on the north side of the road, is a rock of steatite. It appears to be abundant, preparations are making to open a quarry, and it promises to be of advantage to the community. We observed here soapstone in large masses. Talc in broad foliæ, pearl white, grayish white. Tremolite, glassy. Asbestos. Indurated talc.

When we consider that great part of St. Lawrence county is still covered with wood, that few quarries have been opened, and that the above minerals were found in the course of a very hasty examination, it promises to become one of the richest counties of the state to the mineralogist, and merit a more detailed examination.

Art. IV.—*An account of some experiments made by order of Col. Totten, at Fort Adams, Newport, R. I., to ascertain the relative stiffness and strength of the following kinds of timber, viz.:* White Pine, (*Pinus Strobus,*) Spruce, (*Abies nigra,*) and Southern Pine, (*Pinus Australis,*) also called (*Long leaved Pine.**)—*Communicated by* Lt. T. S. Brown, of the corps of Engineers.

The white pine and spruce were obtained from the eastern part of New England, and the southern pine from North Carolina. The

* It is proper to remark, that although there is no reason to doubt that the spruce used was *Abies nigra*, and that the southern pine was *Pinus Australis*, yet it obviously may be very difficult to establish with certainty the botanical name of a kind of wood seen only in the form of *timber*. In the present instance, an attentive consideration of all the circumstances, has given great confidence that the names adopted above are correct, yet those familiar with the subject will at once perceive that in certain cases, the timber of *Abies alba*, might easily be taken for that of *Abies nigra*, and that it might also be difficult to decide between *Pinus mitis* and *Pinus Australis*.

specimens, which were well seasoned, were carefully selected, and were quite free from splits and knots. Three pieces of each kind of wood were taken, each piece being 9.389 feet in length, 2.75 inches in breadth, and 5.5 inches in depth. The distance between the points of support of the pieces under trial, was 7.1 feet. From one end of the beam, one point of support was 0.229 of a foot, or 2.75 inches distant, of course the other bearing point was 2.06 feet from the other end. All the above dimensions were chosen from their being proportional to those which will be actually required in the case to which these experiments refer. The load was applied by means of a strong platform suspended from the beam midway between the points of support. Bricks which had previously been accurately weighed, were used as weights. The deflexions were measured by means of an index attached to the centre of the beam, and a scale so supported as to be independent of the rest of the system. The scale was isolated to avoid any irregular motions that might take place in consequence of the great weights it was necessary to employ; the supports, however, were so securely braced that no motions of the kind were observed. The scale was divided into parts, each of which corresponded to a deflexion in the beam of $\frac{1}{40}$th of an inch for one foot in length; as the distance between the points of support was 7.1 feet, it is easily seen that the length of one of these dimensions was 0.177 of an inch.

This deflexion of $\frac{1}{40}$th of an inch to one foot, was chosen as the unit of the scale, in consequence of its having been laid down by practical writers on the subject, as the greatest deflexion of floor beams or joists, that should be allowed in practice.*

The bricks were slowly and carefully placed upon the platform by two assistants, who kept account of the number in an audible voice. As the beam was gradually bent by the increasing load, the moment when the index pointed to one of the divisions on the scale could be easily observed, at the same time the men, by their counting, gave information of the number of bricks on the platform, which being recorded opposite the deflexion indicated by the scale, gave the weight producing that deflexion. The men going steadily on, soon brought the index down to another division, when the number of bricks was again recorded, and so on until the deflexion was as great as it was proposed to make it, or until the beam was broken; in either case

* See Tredgold's Carpentry, p. 30 to 46.

the load was immediately removed from the platform, a new specimen substituted, the index readjusted to the zero of the scale, and the same operations repeated. By this method the number of useful observations during each trial, was greatly augmented without causing any additional trouble.

From the foregoing description, it will be seen that the loads were not allowed much time to act upon the beams, from which it follows that the weights producing the different deflexions are rather overrated. With regard to the object for which these trials were instituted, this was a matter of no importance, as it could not affect the relation between the different kinds of wood, and upon making some experiments to ascertain the amount of error, it was found so small that it might with safety be neglected.

In the first trial, for instance, (specimen, No. 1, Table [A,] the load of 2662 pounds, which produced a deflexion of $\frac{4}{40}$th of an inch to a foot, instead of being immediately removed, was allowed to remain suspended for two hours and forty minutes, when it was found that the center of the beam had sunk only 0.077 of an inch.

The foregoing observations, with a few explanatory remarks, will, it is hoped, render the following tables intelligible.

TABLE (A.) *Detailed Statement of Experiments to determine the relative Stiffness of White Pine, Spruce and Southern Pine.*

Deflexion in parts of an inch to one foot.	Whole deflexion in inches.	White Pine.		Spruce.		Southern Pine.	
		No. of specimen.	Weight in pounds, producing the deflexion.	No. of specimen.	Weight in pounds, producing the deflexion.	No. of specimen.	Weight in pounds, producing the deflexion.
$\frac{1}{320}$	0.022	1	111	4	126	7	217
$\frac{1}{40}$	0.177	"	836	"	737	"	1187
$\frac{2}{40}$	0.355	"	1516	"	1295	"	2252
$\frac{3}{40}$	0.532	"	2125	"	1960	"	3266
$\frac{4}{40}$	0.710	"	2662	"	2683	"	4078
$\frac{1}{320}$	0.022	2	126	5	131	8	222
$\frac{1}{40}$	0.177	"	715	"	973	"	1195
$\frac{2}{40}$	0.355	"	1448	"	1729	"	2270
$\frac{3}{40}$	0.532	"	2074	"	2464	"	3274
$\frac{4}{40}$	0.710	"	2708	"	3119	"	4259
$\frac{1}{320}$	0.022	3	126	6	146	9	217
$\frac{1}{40}$	0.177	"	781	"	968	"	1145
$\frac{2}{40}$	0.355	"	1491	"	1815	"	2134
$\frac{3}{40}$	0.532	"	2125	"	2449	"	3037
$\frac{4}{40}$	0.710	"	2733	"	3098	"	3996

REMARKS.

Whole length of specimens in feet 9.389
Bearing length in feet - - 7.1
Breadth in inches 2.75
Depth in inches 5.5

In these trials, each specimen, upon being relieved of the load producing the greatest deflexion, sprung back by the elasticity of the wood until the center came within about 0.046 inches of being as high as it was before the experiment commenced. This deflexion of 0.046 inches, would have been still further reduced had more time been allowed.

TABLE (B.) *Being a condensation of the results given in Table* (A), *with other facts connected therewith.*

Kind of Wood.	Specific gravity.	Weight of a cubic foot.	Deflexion in parts of an inch to one foot.	Whole deflexion in inches.	Weight in pounds producing deflexion.	Differences for each division on the scale of deflexions.	Constant quantity (a) in the expression for stiffness, $\frac{B \times D^3}{a \times L^2} = W$.
White Pine.			$\frac{1}{320}$	0.022	121		
			$\frac{1}{40}$	0.177	777	777	$a = 0.0116811$
	·455	28.43	$\frac{2}{40}$	0.355	1485	708	
			$\frac{3}{40}$	0.532	2108	623	
			$\frac{4}{40}$	0.710	2701	593	
Spruce.			$\frac{1}{320}$	0.022	134		
			$\frac{1}{40}$	0.177	892	892	$a = 0.0101751$
	.490	30.63	$\frac{2}{40}$	0.355	1613	721	
			$\frac{3}{40}$	0.532	2291	678	
			$\frac{4}{40}$	0.710	2966	675	
Southern Pine.			$\frac{1}{320}$	0.022	218		
			$\frac{1}{40}$	0.177	1175	1175	$a = 0.0077244$
	.872	54.5	$\frac{2}{40}$	0.355	2218	1043	
			$\frac{3}{40}$	0.532	3192	974	
			$\frac{4}{40}$	0.710	4111	919	
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*

REMARKS.

In the expression for stiffness, $\frac{B \times D^3}{a \times L^2} = W$, (col. *h*,)

(B) represents the breadth in inches,
(D) the depth in inches,
(L) the bearing length in feet, and
(W) the weight.

The constant (a) has only been calculated for a deflexion of $\frac{1}{40}$th of an inch to one foot, as that is a limit which, generally, should not be exceeded in practice; but if any other deflexion is desired, the constant quantity proper for it may easily be obtained by substituting in the above expression, for (L) 7.1, for (D) 5.5, for (B) 2.75, and for (W) the weight in this table opposite the deflexion desired, the value of (a) resulting, is the number of which we are in search.

TABLE (C.) *Experiments to ascertain the circumstances of fracture, giving the aggregate of the results for each kind of wood.*

Kind of Wood.	Deflexion in parts of an inch to one foot.	Whole deflexion in inches.	Deflexion at moment of FRACTURE.	Whole deflexion in inches at moment of FRACTURE.	Weight in pounds producing deflexion.	Weight producing FRACTURE.	Differences for each division on the scale of deflexions.	Comparative strength of white pine, spruce and southern pine, white pine being unit.	Value of the constant quantity (c) in the expression for *strength*, $\frac{B \times D^2 \times c}{L} = W$.
White Pine.	$\frac{4}{40}$	0.710			2656		664		
	$\frac{5}{40}$	0.887			3217		561		
	$\frac{6}{40}$	1.065			3745		528		
	$\frac{7}{40}$	1.242			4062		317		
	$\frac{8}{40}$	1.420			4266		204		
	$\frac{9}{40}$	1.597			4390		124		
	$\frac{10}{40}$	1.775			4560		170		
	$\frac{11}{40}$	1.952			4664		104		
	$\frac{12}{40}$	2.130			4775		111		
	$\frac{13}{40}$	2.307			4833		58		
	$\frac{14}{40}$	2.485			4893		60		
			$\frac{16}{40}$	2.840		5189		1.000	$c=443$
Spruce.	$\frac{4}{40}$	0.710			2806		701		
	$\frac{5}{40}$	0.887			3505		699		
	$\frac{6}{40}$	1.065			3955		450		
	$\frac{7}{40}$	1.242			4443		488		
	$\frac{8}{40}$	1.420			4705		262		
	$\frac{9}{40}$	1.597			4877		172		
	$\frac{10}{40}$	1.775			5051		174		
	$\frac{11}{40}$	1.952			5185		134		
	$\frac{12}{40}$	2.130			5324		139		
	$\frac{13}{40}$	2.307			5441		117		
			$\frac{15}{40}$	2.662		5646		1.101	$c=482$
Southern Pine.	$\frac{4}{40}$	0.710			3698		924		
	$\frac{5}{40}$	0.887			4611		913		
	$\frac{6}{40}$	1.065			5487		876		
	$\frac{7}{40}$	1.242			6268		781		
	$\frac{8}{40}$	1.420			7049		781		
	$\frac{9}{40}$	1.597			7593		544		
	$\frac{10}{40}$	1.775			8033		440		
	$\frac{11}{40}$	1.952			8429		396		
	$\frac{12}{40}$	2.130			8578		149		
			$\frac{14}{40}$	2.485		9237		1.780	$c=788$
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*

TABLE (D.) *Relative stiffness of White Pine, Spruce and Southern Pine, at different deflexions, White Pine at each particular deflexion being taken as unit.*

RATIOS OF STIFFNESS.			
Deflexion in parts of an inch to one foot.	White Pine.	Spruce.	Southern Pine.
$\frac{1}{320}$	1.	1.107	1.801
$\frac{1}{40}$	1.	1.148	1.512
$\frac{2}{40}$	1.	1.086	1.493
$\frac{3}{40}$	1.	1.087	1.514
$\frac{4}{40}$	1.	1.098	1.522
$\frac{5}{40}$	1.	1.078	1.532
$\frac{6}{40}$	1.	1.056	1.465
$\frac{7}{40}$	1.	1.096	1.543
$\frac{8}{40}$	1.	1.102	1.652
$\frac{9}{40}$	1.	1.110	1.729
$\frac{10}{40}$	1.	1.107	1.761
$\frac{11}{40}$	1.	1.111	1.807

Observations on the foregoing Tables.

Although table (B) embodies all the information given in table (A), it is nevertheless thought of some importance to present the results actually obtained in the experiments, the mind is thereby better satisfied, and in this instance the general agreement of those results will tend to inspire confidence. Table (C) contains the average of the results of the original experiments under that head, which were found to harmonize with each other in the same general manner as those of table (A). It may be remarked with reference to the weight producing fracture, that the results given in table (C) are slightly overrated in consequence of the small time occupied in making the experiments; this, however, is no practical disadvantage, as in calculating the strength of timber from algebraical formulæ, large allowance must always be made to provide against accidental defects.

It was observed in all these experiments, that the failures of the wood began at the top. The upper fibres, for rather less than half the depth of the beam, were gradually crushed and broken off in the bending of the specimen, and at last when no more weight could be supported, a fracture suddenly took place, the lower fibres being drawn asunder. It seemed that the bending took place more in consequence of the crushing of the upper fibres than the extension of

the lower ones. The fractures were not sufficiently regular to permit any comparisons to be drawn as to the relative number of fibres crushed and drawn asunder in the different kinds of wood.

The results in columns (*g*) of tables (B) and (C), indicate the weights which were required to bend the specimens through an additional division on the scale of deflexions. If the deflexions were always as the weights producing them, it is evident that all the differences in columns (*g*), would, for the same kind of wood, be equal. It is easily seen, however, as might have been anticipated, that after having passed with considerable regularity through the two or three first divisions, the deflexions begin to increase in a much greater ratio than the weights. From this cause it is very important that in experiments on the stiffness of timber, small deflexions only should be tried, and that those deflexions should be accurately measured.

It may be seen that the weights producing deflexions of $\frac{4}{40}$ths of an inch to one foot are less in table (C) than in table (B), the reason for which is that the stiffness of the wood was diminished by the first trials.

A circumstance of a practical nature connected with these experiments, deserves to be noticed, as it may possibly have modified the results in a slight degree. It was necessary in suspending the load from the beam to adopt some precaution to prevent the iron band connected with the platform, from cutting into the wood, and thereby crippling the timber. The annexed sketch will indicate more clearly than any description, the means that were employed.

Fig. 1.

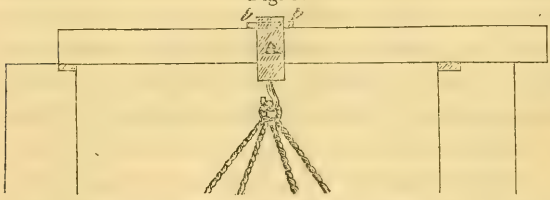

Fig. 2.

(A), (1) and (2) is a strong iron collar, three inches wide and half an inch thick, embracing the specimen under trial, from which, by means of the hook below, the platform containing the load was suspended : (*b*) represents a bar of iron 2.75 inches wide, six inches long, and half an inch thick, resting upon the wood underneath the collar.

It is therefore evident that the load was not applied precisely at the centre point, but upon a surface six inches long, the centre of which corresponded with the centre of the bearing length.

In every instance when the beam was broken, the fracture took place at one end of the bar (*b*), and therefore at the distance of three inches from the true centre.

In the trials relating to stiffness, tables (A) and (B), it is not supposed that this bar modified the results in any appreciable degree, that is to say, the results given in these tables may, without any sensible error, be considered as having been obtained by applying the weight precisely at the centre. The case is different, however, with the results given in table (C); but since the error, whatever it may be, (and that it must be small is evident,) does not affect the comparison of the woods, it is of no consequence as to the particular object had in view.

Some of the *general* inferences to be drawn from the foregoing experiments are:—

1st. That within certain limits which extend much further than it is proper in practice to suffer wood to bend, the deflexions are very nearly as the weights producing them; see table (B), column (*g*).

2nd. When we have a given weight to sustain, so that the deflexions shall not exceed $\frac{1}{40}$ of an inch to one foot, other circumstances being equal, ten beams of southern pine are equivalent, nearly, to thirteen of spruce or to fifteen of white pine. When the deflexions to which the timber is exposed are very much less than $\frac{1}{40}$th of an inch to one foot, or when we merely wish to guard against fracture, the disproportion between southern pine and the other woods, is much greater; see 2nd and 1st lines, table (D) and column (*h*), table (C). It was to obtain the results given in this paragraph, that these experiments were instituted.

Art. V.—*On the Causes of the Aurora Borealis.*

The sublime and beautiful spectacles presented by the aurora borealis, have been in all ages a source of admiration and wonder alike to the savage and philosopher. The ignorant and superstitious view the still mild northern light as a precursor of famine, and the brilliant crimson and other colored flashes, as ominous of pestilence and war;

while the more quiet minded and careful observer has discovered that they are often preludes to high winds and tempests.

Many theories have been proposed to account for the phenomenon, but the explanations are unsatisfactory; the inquiry still arises why the aurora is visible in the temperate and frigid zones, while it is never seen within the tropics—why it is so uncertain in its returns, observing no periodical law—why it is at one time so brilliant, and at other times only a pale gleam in the edge of the horizon—why, in the temperate latitudes, it appears in an arc of the northern hemisphere, while in the arctic circle it is always seen in the south—why it is visible as the twilight appears, and generally extinguished near or soon after midnight—and why it is seen shooting and corruscating in streams and spires, emulating the lightning in vividness, and the rainbow in coloring; and again, silently rising in a compact majestic arch of steady white light, apparently durable and immovable, and yet so evanescent, that while you look upon it, it is not.

The various aspects of the boreal lights in these latitudes are familiar to every one, although it may not be equally well known, that they increase in vividness, splendor and frequency near and within the polar circle. *Maupertuis* remarks, that in *Lapland*, "the sky was sometimes tinged with so deep a red that the constellation Orion looked as though it were dipped in blood, and that the people fancied they saw armies engaged, fiery chariots, and a thousand prodigies," and that the red colors were deemed a presage of misfortune.* *Gmelin* relates that in Siberia, between the Lena and Jenesei, on the confines of the icy sea, "the spectral forms appear like rushing armies; the hissing crackling noises of those aerial fireworks so terrify the dogs and the hunters that they fall prostrate on the ground, and will not move, while 'the ranging host is passing.'"

Kerguelen describes "the night as brilliant as the day," *in lat.* 50°, between *Iceland* and the *Ferro* Islands, "the heavens being on fire with flames of red and white light, changing to columns and arches, and at length confounded in a brilliant chaos of cones, pyramids, radii, sheaves, arrows, and globes of fire."†

But the evidence of Capt. *Parry* is of more value than that of the earlier travelers, as he examined the phenomenon under the most fa-

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* Memoir on the measure of a degree, at the polar circle.

† Kerguelen's voyage to the North.

vorable circumstances, during twenty seven consecutive months, and because his observations are uninfluenced by imagination. He portrays the shifting figures, the spires and pyramids, the majestic arches, and the sparkling bands and stars which appeared within the arctic circle, as surpassing his powers of description. They are sufficient to enlist the superstitious feelings of any people not fortified by religion and philosophy.

To give the reader a comprehensive view whereby to graduate his estimate of the probable causes of this phenomenon, some of the hypotheses which have been advanced will be first noticed, and then an examination, whether the aurora is not attributable to causes and agencies not commonly suspected.

Hypotheses which have been advanced explanatory of the Aurora.

One of the first conjectures on record was that inflammable sulphureous vapors ascended from the earth; but this was objected to by Dr. Halley, on account of the extent of the phenomenon, and the inadequacy of the cause to the effect. It was his opinion that the poles of the earth were in some way connected with the aurora; that the earth was hollow, having within it a magnetic sphere, and that the magnetic effluvia, in passing from the north to the south, might become visible in the northern hemisphere.

Dr. Priestly states "that Beccaria deemed the aurora borealis the regular and constant circulation of the whole mass of the etherial electric fluid from north to south, springing from many sources in the northern hemisphere, and rendered luminous on its near approach to the earth."*

Mairan imagines "that the aurora proceeds from particles thrown off from the atmosphere of the sun by the centrifugal force."†

Various theories, at different periods, attempting to shew that *electricity* must be the cause, have occupied the minds and pens of philosophers. By some, it is ascribed to a destruction of the electrical equilibrium; by others, to a great excess of the electric fluid in the upper regions of the air; and again, to the passage of magnetic effluvia in arches of great circles, rising to immense heights, and sending off forms like radii, perpendicular to the surface of the earth.

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* Edinburgh Encyc. † Ib.

One writer presumes that the electrical fluid is attracted and accumulated by the immense masses of iron, which is a native product of those regions from 32° north lat. to the pole.* Professor Hansteen attempts to account for it by considering it an electro-magnetical phenomenon, but after advancing an extremely elaborate hypothesis upon the influences of "neutralized electricity" which he supposes identical with magnetism, he remarks, "I confess that there still remain various obscurities in this difficult subject, not easily to be solved."† A late writer in the *London Phil. Mag.* attributes it to the reflection of the solar light from the polar ices, refracted by the power of the atmosphere into the upper regions of the air, and again refracted so as to be made visible within certain limits, to the inhabitants of the earth.

Those theories which attribute this phenomenon to electricity, are met by the following unanswerable objections. The electric fluid never accumulates in visible cohesive masses; it is always dispersed through the earth and air, and its tendency is to remain in equilibrio or nearly so, unless when collected by some medium different from the atmosphere, as in thunder clouds; its velocity, when moving, is greater perhaps than that of any other substance, not excepting even light itself, and when it becomes luminous, it is more fugitive than under any other form. The electric fluid never undulates, or waves to and fro in sinuous curves and motions, nor does it settle in banks of steady light, or remain at once luminous and stationary, in any form, in the pure air. Thus it is plain that if the metallic regions were capable of attracting the electric effluvia and suspending them between the heavens and the earth, still there must be some other medium than the pure air to detain and make them luminous. If the medium, and the effect were both produced by that cause, the effect should be constant, for the action of the attracting force is ever in operation, and not occasional and evanescent as the clouds which attract and conduct the lightning.

The magnetic efflux is not only not inherently luminous, but incapable of reflecting light.

The supposition of Beccaria, that the electric fluid in seeking a south pole became visible in its passage from the north, is negatived by the fact, that the aurora appears in the southern temperate zone,

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* Am. Jour. Science, Vol. xvi, p. 291. † Ib. Vol. xiv, p. 110.

rising from the southern horizon towards the north; and the opinion of Halley, that the magnetic effluvia became luminous in their progress from the north to find the south pole, is equally nugatory; for it would be an absurdity to suppose, that those forces were flowing over from the north to seek a south pole, when at the same time the aurora is seen ascending from the antarctic regions.*

Nor can its various phases be accounted for by the reflection of the solar light from the polar ices.

Reflected light falls on those spaces enlightened by direct rays from the illuminating source; hence, if the direct rays of the sun were reflected from the polar ices, there should be no polar night; a constant uniform light should be diffused throughout the arctic regions. If the reflection upon the ice does not proceed from the incident rays, but from the light refracted by the atmosphere, the uniformity of the effect must be the same, although it should differ in the degree of intensity. If the rotation of the earth, or change of seasons, cause a difference, still the effect must be as uniform as the cause, and the phenomenon should be regulated by periodical laws. This is not the case with the aurora, which is signally irregular in the times of its appearance. Nor could the solar light refracted by the atmosphere, and subsequently reflected from ice within the polar circle, be sufficiently intense to illuminate the atmosphere at such an altitude as would render its second refraction visible in the temperate zone, a distance of more than two thousand miles. If the reflection from the ice were the cause, and its effects were uniformly diffused light, how could the fleeting forms of the aurora rise more conspicuous near the pole, than in other latitudes, shooting its spires and crescents perpendicularly to those very ices which reflect the rays to supply its light? Nor could light be atmospherically refracted from an altitude above the pole, which would not be intercepted by the spherical figure of the earth, before it could fall on the lower latitudes of the temperate zone. If the reflection of light from the ices cannot at the same place and same point of time, produce an equally diffused light, and the uncertain forms of the aurora, the phenomenon must be referred to some other agency.

If electricity and magnetism are inadequate to produce the aurora by any known action or combination of their powers; and if the hy-

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* Seen by Forster, who accompanied Capt. Cook, in 1773, in south lat. 58°.

pothesis of light reflected from the arctic ices is untenable, it will be almost superfluous to reply to the doctrine that it proceeds from particles thrown off from the atmosphere of the sun; or that sulphureous fumes are ignited in the air; for "if nature accomplishes her wonders by varying the combination of a few simple means," we need not go to other spheres for the materials which produce the phenomena of ours, nor seek in the most occult causes for the solution of such as are not understood. It is not conformable to the optical phenomena of the celestial bodies, nor to the known properties of light, that a substance inherently luminous, should exist in the atmosphere, in a form so fugitive and irregular as the aurora, not regulated in its returns by periodical laws, but strangely, and almost paradoxically uniform in its place of appearance, and its singular varieties.

These anomalies may be explained by considering the aurora as a meteorological phenomenon, produced by a gaseous medium, illuminated by the refracted and reflected rays of solar light.

A medium possessing a higher refractive power than the mixed oxygen and nitrogen which compose the atmosphere, may exist in it at an altitude sufficient to refract over the particles of light after the direct rays of the sun have so far left the hemisphere, that they are no longer refracted by the atmosphere at such an angle as to be rendered visible in a given latitude. This medium must be presumed to be a gaseous combination, forming an embodied and impressible transparent vapor, reflecting the light from mass to mass like a series of mirrors, which by refraction becomes visible in the darkened hemisphere.

I shall first examine the probability of the existence of such a vapor, and what may be supposed to be its properties; and secondly, the reasons for attributing its illumination to the solar light.

I. *Vapor the basis of the Aurora.*

It must first be *assumed* that vapor is the basis of the aurora, and if the assumption coincides with ascertained laws, it may perhaps be entitled to a degree of confidence, although the sources from which it originates remain unknown. It probably results from a union of elements previously existing in simple forms, combined by the agency of electricity, caloric and light, those ruling powers of the atmosphere.

A medium, consisting of atmospheric air, holding equally diffused through it more than a common portion of water, acquires a great increase of transparency, provided the watery vapor is not condensed

by cold; and if a preponderating quantity of hydrogen be added, it is sufficient to produce *its refractive power*, for, according to Newton, "*inflammable bodies refract much more light than the ratio of their densities.*" "Hydrogen is inflammable, and remains permanent over water, not combining with it in any notable degree."* *Biot* ascertained that "hydrogen refracts light in a ratio independent of its density higher than any other substance." It is much lighter than common air, and consequently is capable of ascending in a gaseous form. It follows that any stratum or sheet of air, in which more than a common portion of water is dissolved, and equally diffused, accompanied by, or possessing an excess of hydrogen, becomes a powerfully refractive medium, with the capacity for reflection essential to the basis of the Northern Lights. What other forces may be in exercise, or what agencies necessary to accumulate this vapor, are not ascertained; it may be analogous to, or perhaps identical with the cause of the *mirage*, a well known refractive vapor, which at various elevations, as well as on prairies and tracts of desert, mocks the spectator with optical illusions, with visions of cities, villages, men, animals and sheets of water, spread in seeming reality over the most arid sands; while in mountainous countries, such as the Hartz and the Scottish Highlands, fantastic images and apparitions give rise to superstitious legends, and compel a belief in supernatural revelations.

I need not take time to detail the various opinions which have been given of the constituent parts of this vapor, none of which are conclusive; but there is sufficient testimony that it exists in almost every country, and that it rises to various elevations in the atmosphere.†

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* Henry's Chemistry.

† It may be objected that the *mirage* always reflects objects horizontally to an observer, who must look down at a certain angle, in order to perceive the image produced by the refraction. But there is evidence that the same or a similar vapor produces optical illusions at various elevations. Baron Humboldt saw stars reflected, and moving like comets, with trains and sparkles after them, from the Peak of Teneriffe, 10,800 feet above the level of the sea. They appeared 7° or 8° above the horizon, and he at first suspected that they were the commencement of a volcanic eruption from a mountain on an adjacent island; but on further observation with the telescope of a sextant, he perceived they were reflected images of those stars then vertical to their apparent place.

Another instance, shewing that this vapor does not invariably hover near the earth's surface, occurred on the south side of Long Island, in the summer of 1827.

But whether it is the identical vapor of the mirage that causes the aurora, is no way material to the argument. The optical phenomena of the higher latitudes, render it probable that *an attenuated and diaphonous medium, different from, and in addition to the air, exists in every place where this phenomenon is apparent.**

In the arctic regions the aurora often appears as near and low as many of the clouds. Capt. Parry says, that "*distinct layers or strata*, seeming to overlap each other, increased the intensity of the light, which at times was something more than the moon in her quarters, dimming the stars, but not concealing them. It was like drawing a gauze veil over that part of the heavens where the aurora appeared." In some instances complete arches or bridges, with well defined edges, arose from a common point, and diverged until 20° apart, when they gradually converged, until they joined in one point in the opposite horizon.†

Sometimes the streams of light were in right lines like rays; at others crooked and waving, and moving with inconceivable rapidity; but the most dazzling corruscations often settled down into a steady arch of yellowish white light. In two or more instances, long dark parallel stripes were noticed, lying horizontally over the arches. These were only separations of the luminous strata, because "the stars were *there* most plainly visible." These openings prove that the aurora consists of strata or films of vapor; for the brilliancy of the stars in the dark sky where the light parted, show that the light

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Two persons crossing a tract of salt meadows, a mile or two from the sea shore, saw an immense column before them, reaching from the ground to the clouds: in a moment, another of the same dimensions rose, apparently a mile west from the first, both in the edge of their sensible horizon. These continued unaltered while they rode a mile, stedfastly looking at them, conjecturing them to be water spouts, when they were instantly gone, and an arch of corresponding dimensions occupied their place. The highest point of the arch was about 12°, and was visible a minute and a half.

* The transparency of the aurora cannot be questioned, because the stars are visible through it; and if the supposed medium exists, it must of course be transparent.

† White luminous clouds, assuming the precise figures of many of the appearances of the aurora, occurred frequently at Melville Island, occasionally "forming a magnificent canopy," as though one section of the heavens was hung in folds of an almost transparent drapery.

"The remarkable resemblance of this and many other forms of the aurora to the appearances assumed by the clouds at certain seasons of the year in the polar regions, may possibly serve to throw some light on the nature and peculiarities of the aurora."—*Parry's Voyages.*

is reflected by a material substance, existing in those places where it is apparent, and that the pure atmosphere does not reflect the light.

The appearance of the phenomenon in Siberia is compared to the *unwinding* of a piece of "flame-colored taffeta;" and in Hudson's Bay it was said to *roll over and over* from one end of an arch to the other; as though a volume of luminous matter was unfolded, and rolled from one point over to supply that which escaped and vanished at the other. Parry further compares the waving motions of the horizontal bands of light, to the sinuous impulse given to a long ribbon by a person holding it at one end. The streams and sheets of light waving to and fro; and the groups which in the Orkneys are called "the merry dancers," moving with inconceivable velocity, show the existence of an aerial medium, surprisingly flexible and attenuated, obeying the impulses of currents and other agencies that agitate the atmosphere.* The steady immovable banks of white light result from the calm that prevails in that tract of the air where they repose.

Although the most frequent displays and brightest splendors of the aurora are within the Arctic circle, it is not there more subjected to periodical laws than in the temperate zone. It varies in every year, no two years being parallel to each other. The differences are analogous to the changes of the weather, but without any dependence upon them. It is probably essential that calms should prevail in those regions of the air where the vapor collects, as strong currents would break up and disperse it. This conjecture is strengthened by the fact, that in the temperate latitudes the appearance of these beautiful visions is a prelude to high winds; and this peculiarity indicates still further that its character has not been mistaken; because calms are proverbially precursors of storms; and within the tropics are infallible harbingers of hurricanes.

The irregularity of its appearance is doubtless chargeable to those unknown influences which at one time favor, and at another prevent the accumulation of the vapor, for probably like the clouds, it prevails only occasionally. Alike variable, and almost as transient, it resembles in *its mutability* the lightning and rainbow; for although the laws which produce those phenomena are understood, yet the auxil-

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* Analogous to those "small streams and currents of air," seen by Humboldt, "chasing trains of clouds with unequal velocity and in opposite directions," in the upper regions of the Peak of Teneriffe and the Cordilleras.

iaries or proximate causes which bring them into action at one time, and not at another, are unknown. The same inconstancy appertains to temperature, drought, rain, hail and snow.

II. *Reasons for attributing the illumination of the Aurora to the Solar light.*

1. It is presumed that this peculiar vapor rests in the atmosphere at no great elevation, perhaps not far higher than the clouds. After the twilight declines, the rays of light which continue to illuminate the upper heavens, fall upon this highly refractive medium, and are thus made visible upon the earth. When it appears immediately after the twilight, it brightens and deepens as the darkness comes on, like the moon and stars. Its commencing occasionally an hour or two after dark, is probably owing to those unknown agencies which collect the vapor at one time and not at another. *The intensity of the light seems to depend upon the quantity of the vapor; and the prismatic colors, on the aqueous particles contained in it.* The prevailing color of the light in both the frigid and temperate zone, is white or yellowish white; and when the deep and glowing hues occur, the vapor probably contains more moisture, and approaches nearer to the condition of clouds.

2. In the temperate zone the phenomenon chiefly occupies the northern heavens, because the sun having so far declined in its diurnal rotation, that the direct rays are no longer subject to the refractive power of the atmosphere above the horizon, they illuminate the upper heavens at an altitude beyond the angle of vision, opposite to the illuminating source. From the oblique position of the sun to the earth, that light falls on the northern quarter, and is made visible in the temperate zone, by being refracted over from that direction, through a medium of greater refractive power than common air. The same medium could not produce the phenomenon in the south and south-eastern quarter in the same latitudes; because the light would be intercepted by the spherical figure of the earth. Thus in the temperate zone, the solar light illuminates the refractive vapor, and produces the phenomenon in the *northern verge of the hemisphere*, and *opposite* the illuminating source.

3. But under what law can it be accounted for, that in the arctic regions it commonly occupies the southern heavens? That portion of the globe receives the solar rays in an increasing obliquity of di-

rection, and they fall so nearly horizontal to the earth as to illuminate the higher heavens far above and beyond the pole; consequently refracted light from the northern quarter, could not be visible on the globe. But the refractive power of the atmosphere increases from the equator to the pole, and in high latitudes produces a twilight of several hours, morning and evening. Even after the sun has set in lat. 74° and 75° for the long night, a beautiful twilight returns periodically in the south, marking his diurnal motion, and the direction of his incident rays. When the direct lines of light are so far withdrawn, as no longer to come within the angle of visible atmospheric refraction, the rays are refracted from the receding twilight by the vapor of the aurora in that quarter nearest the sun; consequently, near the pole the aurora is seen *in the south*, which *is not opposite*, but *in the direction* of the illuminating source.

4. It commonly appears as soon as it is dark, and disappears before midnight, which further indicates its dependence on solar light; for owing to the greater refractive power, and the altitude of the vapor, it reflects the light, as long as either the direct or refracted rays reach an elevation that will fall upon it. It is then visible upon the earth, but when the sun is in the nadir, the light is so withdrawn at that point of time, as to be invisible between the zenith and horizon. Within the temperate zone it has sometimes been seen at midnight and in the zenith, both which anomalies must result from the light reflected from one mass to another; but these instances are of rare occurrence. There is a region, however, a sort of neutral ground, between the point where it ceases to appear in the north, and begins to appear in the south, where it is seen in every quarter of the heavens, probably comprehending a belt around the globe, between N. Lat. 65° and the Arctic circle. Over these latitudes the sun's rays, from their increased obliquity, enlighten a tract of the heavens, without being intercepted by the figure of the earth, and at the same time illuminate the air at such an angle, that the refracting medium renders the light indiscriminately visible throughout the hemisphere.*

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* I think the intensity of the light probably owing to two causes; the quantity of the vapor present, and the precise degree of the sun's obliquity. I cannot think that the increased refraction is caused by the increase of atmospherical density, for the barometrical pressure was not at its maximum when the aurora was most splendid at Winter Island in lat. 66°. Nor does the difference of density between the tropics and the high latitudes seem sufficient to account for the brilliancy of the arctic

5. None of the locomotive properties of the aurora are more uniform, than its inclination to form an arch; for however variable its figures and motions, an arch, although sometimes irregular, generally circumscribes the phenomenon. This is formed by the refraction over the spherical figure of the earth.

6. The splendor, intensity and frequency of the phenomenon increases from the temperate regions to the Arctic circle. The magnificent aurora of Sept. 1827, was noticed through New York, New England, the Canadas, and the north of Europe. In Quebec, N. Lat. 46°, it was much more brilliant than in New York, Lat. 41°, while at Baltimore, Lat. 38°, it was but a faded resemblance of that seen in the northern States, and south of Maryland it was not noticed, probably not seen at all.* This coincides with the laws of refracted light, for the power of refraction increases from the equator to the pole. Before the commencement of the polar summer, the twilight continues till midnight in the Arctic regions; while under the tropics there is very little refraction, no evening twilight or morning dawn.

7. As the beautiful prismatic hues, which often increase the splendor of the aurora, must be referred to the reflection of the light upon the watery particles contained in the vapor, so they also indicate the proportion of water diffused through the strata, and the angle at which the light is reflected.

Effects upon the Magnetic Needle.

It has been extensively admitted that the aurora influences the magnetic needle, from which it has been inferred that magnetism is in some way a cause or an effect of the phenomenon. But the effect upon the needle does not appear to be well ascertained. Capt. Parry, assisted by the scientific gentlemen of his expedition, made the strictest observation in order to establish the amount of its influ-

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twilight, which is described as being often of the richest crimson, purple and orange, of great depth and splendor. Baron Humboldt states the maximum of the barometer at 28 inches at the foot of the Peak of Teneriffe, lat. 28°. At Winter Island, lat. 66°, it was 30 inches. Prof. Olmsted's table makes the maximum of the barometer at New Haven 30 inches in 1827. I have employed round numbers, although there were perhaps a few lines more than 30 inches in each case; but the difference of two inches in 38° of latitude, seems, as regards increase of density, altogether insufficient to produce the amount of atmospheric refraction existing at the pole.

* American Journal of Science, Vol. xiv.

ence, but in no instance could they discern the least impulse of difference, although the meteor was so low as to be visible in strata, and so near, in one instance, as to stream down to the ground not many furlongs from his ship. Humboldt, in conjunction with Mr. Olmann, of Berlin, suspected "a change in the magnetic intensity," attributable to this cause; and Capt. Franklin thought the variations at Fort Enterprize were much affected by the vividness of the prismatic hues; but as the observations of several naturalists in the exploring expeditions, were made under circumstances to insure the greatest possible accuracy, and in those latitudes where the phenomenon displays its most frequent and most wonderful phases, and where its greatest influence should consequently be felt; and their testimony being unequivocal, it seems probable that its imagined effect upon the magnetic force is attributable to some other cause.

Many have reported that the moving figures were accompanied by crackling noises and explosions, but the evidence is not clear on this point. No individual has at any time heard any report within the polar regions. When the aurora was rolling, flashing, rushing, and changing with a velocity that struck beholders with astonishment, if the motions had not been noiseless, they must have been heard in the deep stillness of the Arctic night.

If it is objected that the examples adduced in support of principles, have been taken from high latitudes, and are therefore not applicable to the nature and origin of the meteor in other regions; I reply that I have done so, believing that in every place where it appears it has the same cause; is illuminated by the operation of the same laws; and that by their increased effect in the high northern regions, the causes are more obvious, and their developement more attainable. Whenever the agency of caloric and electricity, in their dominion over the atmosphere, can be fathomed and estimated, the value of many occult problems in meteorology will be understood; but until then, we can scarcely hope that the occurrence and duration of storms, the changes in temperature, and the formation of *meteors*, will be calculated with mathematical exactness.

In conclusion, it appears probable, that the aurora borealis is a meteorological phenomenon, caused by a vapor of extreme levity, tenuity, and transparency; susceptible of motion from the slightest breath that stirs the air, and refracting to an extraordinary degree, the rays of Solar Light.

New York, October, 1830.

Art. VI.—*On the proximate causes of certain Winds and Storms;* by Prof. E. Mitchell, Univ. of North Carolina.

The four following propositions may be regarded as statements of general facts which have been sufficiently established by numerous observations in various parts of the world.

I. That part of the great oceans which lies between the 30th parallel of latitude on both sides of the equator, is constantly swept by a wind varying but a few points from the east.

II. Between the latitudes of 30° and 60°, in both the northern and southern hemisphere; westerly winds predominate over those from the east quarter in a ratio probably somewhat greater than that of 3 to 2.

III. There is in all latitudes, (a few tracts of limited extent where local causes have a decided effect excepted,) a predominance of winds blowing from the poles towards the equator, over those moving in the opposite direction—but this predominance is not as well marked and decided as that of the westerly over the easterly winds, between the latitudes of 30° and 60°.

IV. During the warm weather within the temperate, and at all seasons within the limits of the torrid zone, the fall of rain is often accompanied by lightning, thunder and violent winds, constituting what is commonly called a thunderstorm. Thunderstorms generally commence between mid-day and sunset, and move from west to east.

Other general facts might be added, but these are such as require to be viewed in connexion when the laws which regulate the movements of the aerial currents over the surface of the globe, and the origin of those currents are to be investigated. The truth of the statements contained in these propositions will first be shewn, after which an inquiry will be instituted respecting the causes by which the facts asserted in them may be supposed to be produced.

I. *That part of the great oceans which lies between the 30th parallel of latitude on both sides of the equator, is constantly swept by a wind varying but a few points from the east.*

The direction, velocity, permanence and other characters of the trade winds, are too well known to require any particular remark. They are affected by a number of local causes. Near the equator they blow from the east point, but at a distance from it their course becomes inclined to the parallels of latitude, so as to be at length from the north east and south east, near their northern and southern limits. Their force and direction are also influenced by the proximity of islands and continents. Along the western side of Africa,

their direction is reversed; to the distance seaward of about three hundred miles, they blow towards the land, and nearly at right angles to the coast.

Halley notices a tract between the 4th and 10th degrees of north latitude, and the longitudes of 17° and 23°, "wherein it were improper to say there is any trade wind, or yet a variable one, for it seems condemned to perpetual calms, attended with terrible thunder, lightning and rains, so frequent that our navigators, from them, call this part of the sea, the Rains; the little winds they have are only some sudden uncertain gusts of very short continuance and less extent, so that sometimes each hour there is a different gale which dies away into a calm before another succeeds; and in a fleet of ships in sight of one another, each will have the wind from a different point of the compass; with these weak breezes, ships are obliged to make the best of their way to the southward, through the aforesaid 6°, wherein it is reported some have been detained whole months for want of wind."*

Instead, however, of being confined to these longitudes, it would appear that either a total cessation or a remission of the force of the trades is observed between the latitudes specified throughout nearly the whole extent of both the Atlantic and Pacific: the effect being however more distinctly marked and perceptible in the former than in the latter ocean. A few quotations are given; it would be easy to add largely to their number.

"The southern trade wind being cooler in like latitudes than the northern, usually passes the equinoctial into the northern hemisphere. The northern trade wind falls considerably short of it, as earlier attaining the maximum of heat. Between them is the region of variable winds, light airs and calms, attended with frequent squalls and rain; an uncertain wavy zone lying between the times of their influence. It is the tract in which the highest temperature prevails throughout the year; not at the equinoxes only, the sun being then vertical, but also when he is distant at the tropics. In this warm and damp region of the middle Atlantic, situated in the vicinity of the equator," etc.†

"After a most rapid run of several days, we reached the "*swamp*," as the captain calls the calm and rainy latitudes, between the north-

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* Philosophical Transactions for 1686.

† Colebrooke's Meteorological observations in a Voyage across the Atlantic, in Brande's Journal.

east and south-east trade winds, a few degrees north of the equator —clouds and tempests seem gathered before us. The "*swamp*" was much less formidable than we expected; we have had but little rain, only a short calm, and no thunderstorm, though the "artillery of the heavens" has been heard almost constantly at a distance. We crossed the line yesterday morning, in longitude 24 degrees west."*

"About the period of the last date, we *entered the north-east trade winds*, and have been rushing on before their freshness at the rate of more than two hundred miles a day."†

"We resumed our course to the north, (from latitude 2° N.) having fine weather and *a gentle breeze*, at east and east-south-east, till we got into the latitude of 7° 45′ north, and the longitude of 205° east, where we had *one calm day*. This was succeeded by a north-east by east and east-north-east wind. *At first it blew faint, but freshened as we advanced to the north.*"‡

Between the longitudes of 160° and 172° east, and in the latitudes specified, Commodore Byron had "*only faint breezes with smooth water*"—"we most ardently wished for a fresh gale, especially as the heat was still intolerable, the glass for a long time having never been lower than 81°, but often up to 84°."||

II. *Between the latitudes of* 30° *and* 60° *in both the northern and southern hemisphere, westerly winds predominate over those from the east quarter, in a ratio probably somewhat greater than that of* 3 *to* 2.

(*a*.) Daniell states that "in Great Britain, on an average of ten years, westerly winds exceed the easterly, in the proportion of 225 to 140."§

(*b*.) The meteorology of Cotte, in three vols. 4to, is a vast repository of facts in this science, of very unequal value. It appears from the tables contained in the last volume, that, generally, in the central and western parts of Europe and in some parts of Asia, westerly winds prevail. This is the case in most parts of France, at Amsterdam, Rerne, Berlin, Stockholm, St. Petersburg, Aleppo, Bassora and Bagdad—Copenhagen is the only European capital of which an account is given where this is not the case. "The wind is inclined to west at Paris." (Young's Philosophy, Vol. ii, p. 255.) See also Annals of Philosophy, for July, 1822, where it is stated that at St.

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* Stewart's Journal in the Atlantic.

† Stewart's Journal in the Pacific, W. Long. 134°, Lat. 8½°.

‡ Cook's Last Voyage. || Hawkesworth's Voyages, Vol. i, p. 138.

§ Meteorological Essays, p. 114.

Petersburg, from 1772 to 1792, to which period, with the addition of 1818 and 1819, the observations are confined, "*the west wind prevailed the most, and the south wind the least.*" The numbers expressing the ratios of the winds from the different quarters are not given, except for the year 1818, when the westerly winds were to the easterly as 178 to 111.

(*c.*) Westerly winds predominate over those from the east quarter within the limits of the United States. See the different meteorological tables furnished for publication in the former numbers of this Journal, by Messrs. Beck, Field, Hildreth, Hitchcock, and especially the abstract of the meteorological registers kept at the several military posts of the United States, drawn up by Dr. Lovell, and inserted in the 12th volume, page 153, where the westerly are to the easterly winds, for a term of four years, in the ratio of 12.59 to 9.63.

(*d.*) That west and south-west winds prevail in that part of the Atlantic Ocean which lies beyond the northern limit of the trade winds, is so well known that quotations in proof of it can hardly be necessary. (See Bowditch's Navigation.) "Have we not reason to believe that the *almost constantly prevailing west and south-west winds* which cause the voyage from New York or Philadelphia to England, to be called, down, and from England back, up, as well as that which blows at the top of the Peak, are the upper equatorial current which has here descended, to skim the surface of the ocean."*

(*e.*) Commodore Krusenstern, as quoted by Wallenstein in the Boston Journal of Philosophy, Vol. iii, p. 282, states that "in the Pacific Ocean from latitude 30° to the pole, the variable winds are generally from the north east and south west."

(*f.*) The following statements are from Encyclopedias and other compilations. During a term of sixteen years the westerly were to the easterly winds in Russia, as 172 to 106. East winds prevail in Germany. West winds are most frequent on the N. E. coast of Asia. In Nova Scotia north west, and at Hudson's Bay *west* winds blow for three fourths of the year.

(*g.*) Our information respecting the winds of the southern hemisphere is less ample. Cape Horn (lat. 56°,) has long been infamous amongst navigators for the violent westerly gales that prevail there, rendering it sometimes almost impossible to sail round from the Atlantic into the Pacific. (See Stewart's Journal.) "The prevailing winds of this region are heavy gales from the west, the direct course

* Von Buch, on the climate of the Canary Islands, in Jameson's Journal.

to be steered in passing the cape, and ships are often detained by them three times the period we have been, (twenty one days,) and meet with weather far more dangerous and severe; so much so, that many vessels, after striving in vain for weeks here to make a passage into the Pacific, have been obliged at last to bear away for the Cape of Good Hope, and make their voyage across the Indian Ocean."

(*h.*) In an account of the Falkland Islands by William Clayton, Esq. inserted in the Philosophical Transactions for 1776, it is stated that "The prevailing winds are from the south to the west for two thirds of the year, and in general, boisterous and stormy."

(*i.*) "In the southern Atlantic, at the extremity of South Africa, the winds are periodical, consonant during summer to the south east trade, which constantly blows on each side of the promontory; but conforming in winter with the *western wind that prevails at all times in the Southern Ocean.* In other words, the fluctuating boundary of the western current of air touches upon the extremity of the African continent in winter, and recedes from it in summer."*

III. *There is in all latitudes (a few tracts of limited extent where local causes have a decided effect excepted,) a predominance of winds blowing from the poles towards the equator, over those moving in the opposite direction—but this predominance is not as well marked and decided as that of the westerly over the easterly winds, between the latitudes of* 30° *and* 60°.

(*a.*) Daniell states that in Great Britain, upon an average of ten years, "the northerly winds are to the southerly as 192 to 173," and that "in the central parts of Europe the northern winds are much more regular; and there especially in summer, the Etesian breeze constantly prevails."

(*b.*) Cotte's tables do not indicate the predominance and permanence of northerly winds in that quarter of the world which is asserted by Daniell. Of the capital cities heretofore mentioned, Aleppo, Bassora, Berne, Petersburg and Stockholm, appear to have an excess of northerly winds; Amsterdam, Berlin and Copenhagen of southerly, whilst at Bagdad and Paris the excess on either side is inconsiderable. These tables were however, published in 1788, after the work to which they are attached, had been in press for some years; the information they afford respecting Germany is very meagre, whilst the subject of meteorology appears to have excited an extraordinary degree of interest in that country between the years

* Colebrooke on the climate of South Africa, in Brande's Journal, Vol. xiv, p. 250.

1781 and 1792, so that Daniell may have had access to documents by which his assertions were fully warranted.

(*c.*) It is stated in the Encyclopedia Perthensis, that at St. Petersburg the northerly winds were found during a term of sixteen years, to be to the southerly as 133 to 119, (the westerly were to the easterly as 133 to 92,) and that *in the Mediterranean the north wind blows for nearly three fourths of the year.* Other citations might be made from the same quarter, but their bearing upon the question before us is, doubtful, as merely the point from which the wind blows during the greatest number of days is specified without any notices, by which the relative proportion of northerly and southerly winds may be determined.

(*d.*) In that part of the Atlantic Ocean lying beyond the northern limit of the trade winds between the United States and Europe, it appears that southerly winds predominate.* Their cause is probably analogous to that of the Gulf Stream.

(*e.*) Of the meteorological registers that have been published in this Journal, some, as those of Messrs. Field, Olmsted and Wallenstein, shew an excess of northerly winds; others as those of Drs. Beck, Lovell, and probably Hildreth, an excess of southerly winds, but in general, the excess of the southerly over the northerly where it obtains, is less than that of the westerly over the easterly. Thus, in the abstract of Dr. Lovell, the westerly winds are to the easterly as 12.59 to 9.63—the southerly to the northerly as 12.59 to 11.60. On the whole there can be little room for doubt, that the winds from the north predominate over those from the south within the limits of the United States. This method of estimating the amount of wind in any direction, by the number of days it blows from that point, is exceedingly defective, and may (as where the wind is commonly violent in one direction and gentle in another, and the force with which it blows is altogether neglected,) lead to the most erroneous results. This happens to be the case in this country. Our south west winds prevail chiefly in the summer season; they are mild breezes, subsiding often into a calm, which continues during a considerable part of the day. Our north west winds on the other hand, sweep over the continent day and night, with a constancy and velocity, which renders it necessary to make a considerable allowance when we are es-

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* See the quotation from Von Buch.

timating the amount of movement in the atmosphere by the time during which it occurs.

(*f.*) "The north winds (los nortes,) which are north west winds, blow in the gulf of Mexico from the the autumnal to the spring equinox. These north wind hurricanes generally remain for three or four days and sometimes for ten or twelve."*

(*g.*) If there be a predominance of either northerly or southerly winds in the North Pacific Ocean, it is not such as to have attracted the particular attention of navigators. "On the *north west coast* of America from the straits of Behring to 30° of northern latitude, the winds are variable. Capt. Cook found in March, in the 44th degree of latitude, a fresh and constant north west, which continued until the beginning of summer with the exception of a south east, which lasted however, only six hours, and La Perouse, Portlock and Dixon did not experience the south winds in the summer. According to Vancouver and the Spanish navigators, the north and north west are the most prevailing. (Krusenstern.) All this however applies, almost exclusively, to the summer months. During the winter, Messrs. Lewis and Clarke at the mouth of the Columbia River, had long continued gales from the S. W. and deluges of rain.

(*h.*) The violent winds that prevail at Cape Horn are not accurately from the west point, but from some other between the west and south. "I cannot in any case, concur in recommending the running into the latitude of 61° or 62° before any endeavor is made to stand to the westward. We found neither the current nor the storms, which the running so far to the southward is supposed necessary to avoid; *and indeed, as the winds almost constantly blow from that quarter, it is scarcely possible to pursue the advice.*"†

(*i.*) Cook's voyages into the high latitudes of the southern hemisphere being made when the sun was in the neighborhod of the southern tropic, cannot be referred to as affording information of unquestionable accuracy respecting the winds that prevail in those seas.

IV. *Thunderstorms generally commence between mid-day and sunset, and move from west to east.*‡

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* Humboldt's New Spain, Book I, Chap. 3. See also Poinsett's Mexico, in regard to the violence of these winds.

† Cook, in Hawkesworth's Voyages, Vol. 2. See also Clayton's account of the Falkland islands quoted above.

‡ In an easterly direction, not in the plane of the prime vertical.

The peculiarities of thunderstorms, (under which hailstorms, lately the subject of a learned and accurate paper in the Journal, are included as a particular case of a more general phenomenon,) are probably less strongly marked on the eastern than on the western side of the Atlantic. It may be stated as one ground of this opinion, that they do not seem to have attracted the attention of European poets, either ancient or modern, as copious sources of illustration and imagery as strongly as was to have been expected, had they often presented that succession of striking appearances which is witnessed in the United States. It is not recollected that there is to be found elsewhere in poetry, as accurate a description of the commencement and progress of a thunderstorm, as is furnished by President Dwight's Conquest of Canaan; and though intended to be, as it probably is, a correct account of this meteor as it occurs in the land of Judea, the author doubtless copied from those impressions, which nature herself had made upon his own imagination and memory. The time of its commencment and the direction of its motion, are clearly indicated in the first four lines.

"*Long* rush'd the victors o'er th' ensanguin'd field,
"And scarce were Gibeon's lofty spires beheld,
"When *up the west* dark clouds were seen to rise,
"Sail'd o'er the hills and lengthen'd round the skies."

(*a.*) Such persons as have paid any attention to the changes of the weather in this country, must be well aware that our thunderstorms begin in the after part of the day, and move from west to east. They sometimes occur at night, but seldom after midnight. The direction of their motion does not appear to depend upon the predominance of the westerly over the easterly winds, being much more constant and uniform than that predominance, but to be *a result and a proof of a commotion, excited in the atmosphere at the time of their formation, and of a rush of the air from the west towards the east, in consequence of some new impulse just then communicated.*

(*b.*) The author of the article "Thunder," in the Encyclopedia Perthensis, states, that along the eastern side of the island of Great Britain, it is more frequent in the month of July than at any other time of the year, which he attributes to the circumstance that a wind from the west then succeeds to the east wind that had prevailed from April till the end of June. "For the most part however the west

wind prevails, and what little motion the clouds have is towards the east, whence the common remark in this country, that *thunder clouds move against the wind.* But this is by no means universally true, for if the west wind happens to be excited by any temporary cause before its natural period when it should take place, the east wind will often get the better of it, and *the clouds, even although thunder is produced, will move westward.*" That the most common and natural course of thunderstorms in that country is from west to east, is therefore very apparent.

(*c.*) Of the remarkable thunderstorms experienced in England, from the year of the foundation of the Royal Society, down to 1800, and noticed in the Philosophical Transactions, there are about thirty-five, the time of whose commencement, or in general of their occurrence, is either distinctly stated, or clearly indicated, in the abridgement by Hutton, Shaw and Pearson. Of these, the beginning of twenty-seven was between noon and midnight; generally it was about three or four o'clock in the afternoon. One lasted all day, and the remaining seven were in the morning. The *direction* of twelve is given. Two came from the south, three from the eastern and seven from the western quarter.

If the wind blow for a great length of time, or frequently at intervals from a particular point in any country, the fact will be likely to be noticed by the traveller who may happen to be upon the spot, and stated in his journal, whilst the direction of the gust during a storm, in which he may be involved, will be altogether neglected. For this reason it is more difficult to furnish *proof* that thunderstorms follow a particular course, than to establish the prevalence of certain winds in given latitudes. It is but reasonable that this should be borne in mind, if the evidence adduced in establishing our proposition should not be regarded as in every respect satisfactory. The bare silence of an Englishman or inhabitant of the United States, in regard to the quarter in which a thunder-cloud rises, furnishes ground for believing that it is the same as in his own country. Many sources of information and argument, which would willingly have been consulted, are not at hand.

(*d.*) Dr. Young, giving the substance of a paper by Longford, in the Philosophical Transactions for 1698, on the hurricanes of the West Indies, remarks from it, that "All hurricanes begin between

north and west. Their course is generally opposite to that of the trade winds. Tornados come from several points."*

(*e.*) "This is the wet season, but the rains by no means descend from morning till night, as in some other tropical countries, but commence generally every afternoon about four or five o'clock, with a thunderstorm.——Formerly these diurnal rains came on with such regularity, that it was usual in forming parties of pleasure, to arrange whether they should take place before or after the storm.——In the excursion made from Villa Rica to Labara, it will be seen that violent thunderstorms were experienced almost daily; and I could not help noticing the way these storms commenced. The sky was perfectly clear until about two or three o'clock, when some light white clouds were seen approximating the sun with great rapidity. Sometimes they all passed, but if one lingered as if within its influence, thunder was heard, and in a few minutes no remains of a blue sky were visible. The storm commenced directly." Commencing in the direction of the sun at two or three o'clock, these storms of course begin in the west.†

(*f.*) "Thunder and lightning are ten times more frequent than in Spain, *especially if a storm comes from the north-west.* During my residence in Paraguay, several persons fell victims to lightning, and in the city of Buenos Ayres, in a storm on the 21st of January, 1793, it fell in thirty-seven different places, and killed nineteen people. These storms of wind, thunder, rain, and lightning, cannot be attributed to the influence of mountains, as there are none within one hundred leagues.‡

(*g.*) "Les vents de Nord N. de Nord-Ouest sont ceux que amènent les gros temps et les ouragans dans les mois d'Avril, Mai, Juin, Juillet et Aout; mais ces ouragans, quelquefois furieux ne sont pas fréquens." The months specified, constitute the rainy season. "La grèle ne tombe guère que dans la saison pluvieuse: le tonnere ne se fait aussi entendre que dans cette saison mais rarement; on ne voit les éclairs de chaleur que par un temps couvert et jamais par un temps chaud et serein comme il arrive ordinairement en Europe." De la Cailles' meteorological observations at the Cape of

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* Philosophy, Vol. ii, p. 458. It is hardly necessary to observe that a hurricane is a violent thunderstorm.

† Caldcleugh's Observations in Brazil, in Brande's Journal, vol. xiv.

‡ Azara's Travels in S. America, quoted in the Anti-Jacobin, vol. xxxiv. p. 456.

Good Hope, as quoted by Cotte. Ouragan and hurricane are the same word, and stand for very nearly the same idea in the two languages.

(*h.*) "Le même Académicien (Guettard) a observé que le vent le plus dominant, (at Warsaw) est le *Sud-Ouest qui y cause souvent des ouragans*, ensuite le Sud et enfin le Nord et le Nord-Ouest."*

(*i.*) Russel states, that at Aleppo, in the month of September, "Lightnings are very frequent in the night time, and *if they are seen in the western hemisphere, they portend rain, often accompanied with thunder.*" There is little room for doubt, that all the thunderstorms that occur there, come from the same quarter, but I have met with no passage that is quite decisive.†

(*k.*) Compare Joshua, x, 11—1 Sam. vii, 10, and xii, 18—1 Kings, xviii, 41 to 46—and Luke xii, 54, for the time and course of the thunderstorms in Palestine; especially the latter text: "When ye see a cloud rise out of the west, straightway ye say there cometh a shower; and so it is." In the other cases, there was a particular interposition of the Deity, but in such a way doubtless as to produce effects according to the ordinary course of nature. Hence, after there had been "a sound of abundance of rain" or thunder, Elijah went to the top of Carmel, and sent his servant to look *westward* over the Great Sea: there arose at first "a little cloud out of the sea like a man's hand," but the heaven was soon "black with clouds and wind, and there was a great rain." It is stated particularly that these occurrences were some time after mid-day. Verse 29.

(*l.*) "In the beginning of April, and sometimes earlier, particularly in the south-eastern quarter of Bengal, there are frequent storms of thunder, lightning, wind and rain, from the north-west quarter, which happen more frequently towards the close of the day than at any other time. These squalls moderate the heat, and continue until the setting in of the periodical rains." It is stated farther, that "during the dry season, the heat of the middle districts is lessened by occasional thunderstorms, named *north-westers.*"‡

(*m.*) "Thunderstorms are very frequent at Batavia, especially towards the conclusion of the Monsoons, when they occur almost every evening."§

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* Cotte, Vol. i, p. 365.

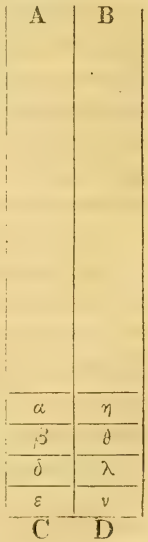
† See Calmet's Dictionary, Vol. iii, p. 497.

‡ Hamilton's account of Hindostan. § Stockdale's Java, p. 36.

(*n.*) It is stated by Veicht in the Philosophical Transactions for 1764, that in "Bencoolen road, on the S. W. side of the island of Sumatra, as well as in the strait of Malacca, you have periodical winds, which blow for six months of the year from the same quarter of the horizon, and the other six months from the opposite quarter; and it is observable that these thunder showers and squalls of wind usually come contrary to these stated winds, which are calmed during the thunder, but return to their constant quarter as soon as the thunder and rain are past." Also by Shotte in the Transactions for 1780, that at the mouth of the Senegal River, during the rainy or sickly season, which begins about the middle of July, and ends about the middle of October, "the wind is generally between the points of east and south, *the quarter from which the tornados come.*" It appears also from Major Denham's account of the rainy season at Kouka, in Bornou, that in that country the thunderstorms are generally from the north-east and south-east. These are exceptions to our general doctrines, produced by local causes, such as are perpetually occurring in every part of the science of meteorology.

Of the prevalent movement of the air in winds and storms.

It may be of use, before proceeding to account for the general facts stated in the commencement of this paper, to turn our attention to the general theory of winds, and the causes by which these movements in the atmosphere are generated. This theory is indeed abundantly simple and familiar to philosophers, but too much neglected by them when treating of meteorological phenomena. Let AC, BD be two adjacent columns of air, of which AC rests upon a sandy plain, and BD upon a forest or some other surface at D, less susceptible of being heated by the sun's rays. Let $\varepsilon\nu$, $\delta\lambda$, $\beta\theta$, be corresponding strata of the two columns of equal thickness and elevation. The pressures on the opposite sides of the plane separating the two columns at ε and ν, will in the first instance be equal, but the portion ε of the column AC being heated by its contact with the hot sand at C, will be expanded so as to fill both ε and a part greater or less of δ. The strata of air lying immediately above, will be lifted up out of their natural positions δ



into β and β into α. The elevation will not be extended to the whole column, but limited to its lower strata, it being in all cases the effect of the expansion of a given portion of air, to produce a condensation and displacement of the air in its neighborhood, to which the immediate effect is confined: δ will therefore be condensed, and at the same time lifted into the position β, where, exerting in the direction of θ the same pressure as when in its original situation, this pressure will not be fully counteracted by the elasticity of θ, but a part of δ will flow into θ. Up to this time there could be no motion in the lower strata ε and ν; the original pressure upon each remaining unchanged, but as soon as a part of δ flows into θ, the pressure upon ε being diminished, and the pressure upon ν increased, ε, the lighter, will give way, and ν move in to supply its place. At the same time δ, now in the position θ,' will descend into λ. By a continuance of the motion it will sink to ν, pass into ε, and being heated there, will ascend into its original position δ. The air thus set in motion, retaining the momentum it has gained, and receiving a new impulse from time to time, a horizontal whirlwind moving with greater or less rapidity, will be formed. A person living at the foot of the columns at C and D, and having no notice of what is going on over his head, will suppose there is simply a horizontal wind at his part of the earth's surface, in the direction of $\nu\varepsilon$. A similar motion of air, but in the opposite direction, will be produced by the condensation of the air at ε.

In every case of wind, the *primary* movement is upwards or downwards in a vertical plane. Of this, the horizontal current felt at the earth's surface, is only a secondary result. It is not possible that it should be generated by those causes which affect the condition of our atmosphere, except according to the methods here represented, and we are warranted in laying down the following proposition.

The phenomena of winds and storms are the result of a vortex or gyratory movement, generally of no great extent, established in that region of the atmosphere where they prevail.

To such persons as have been much conversant with writings on the subject of Meteorology, no apology will be necessary for the formal enunciation of this proposition and the subjoined illustrations. They must be well aware that winds are generally spoken of as long aerial rivers, flowing from one part of the earth's surface to another, with scanty and imperfect, if there are any, notices of the fact, that *they owe their existence to another movement of the air at right angles to their*

own course. These obscure and erroneous views of the nature of that motion of the air, which constitutes wind, seem to pervade most of the meteorological speculations of an individual holding a high rank amongst the philosophers of the age—Mr. Leslie, of Edinburgh. See his investigation of the causes of the oscillations of the mercury in the barometer, and his illustrations of the Huttonian theory of rain—(*that it is produced by the mingling of air of different temperatures, charged with moisture*) referred to by Playfair, (Outlines, Vol. i, p. 316) with approbation, as containing a correct exhibition of the rationale of falling weather.

"To explain the actual phenomena, we must have recourse to the mutual operation of a chill and of a warm current, driving swiftly in opposite directions, and continually mixing and changing their conterminous surfaces.* (Leslie on heat and moisture, p. 139.)

If the two currents come from opposite directions, the motion of both will be destroyed, or one will drive the other back before it, along its former track. In either case, there will be a mixture of

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*This passage appears a second time, without any alteration of the language in the article Meteorology, drawn up by the same author, for the Supplement to the Encyclopedia Brittanica, ten years after the publication of the account of experiments respecting heat and moisture, so that he seems to regard this theory either as not admitting of, or not requiring any correction or improvement. In the fifteenth Volume of this Journal, at page 12, is an "Hypothesis on Volcanoes and Earthquakes, by Joseph Du Commun, of the Military Academy at West Point." It has the stamp of originality, and no one who reads it over, will doubt that it is the result of the unaided operations of his own mind; but if the author of that paper will examine this article of Leslie's, in the Encyclopedia, he will find that he has been anticipated in all the points of his hypothesis. Indeed, if the writer who furnished an analysis, with critical remarks of Professor Leslie's speculations for Brande's Journal, is to be believed, it did not originate with him, but with an individual whom we should hardly expect to find engaging in this kind of speculation—Dr. Southey, the Poet Laureate.

"We think this the wildest conceit that has ever figured in a sober work on philosophy. It throws Bishop Wilkins' schemes quite into the shade, and seems to rival some of Mr. Southey's oriental fictions, from one of which, the Donndaniel cavern, it is manifestly borrowed. We shall not consume our reader's time with a serious refutation of this shower of atmospheric air drops, pushing themselves down the watery abyss, from five and a half miles beneath the surface to the very bottom. Nor shall we alarm their fears for the respiration of posterity, when this unceasing operation shall have smuggled the whole atmosphere into its submarine vaults. We shall merely congratulate old Ocean on the possession of this soft, elastic and self-adjusting pillow. To complete this new Neptunian theory, Mr. Leslie should have shewn how, when this pillow becomes over-stuffed, the surplus air could be squeezed out, as occasion required, through one of Pluto's spiracles, to inflate the bellows of the Cyclops." Journal for October, 1822, pages 177—8.

the different portions of air only at the plane where they meet, and this will be altogether inadequate to the production of a copious rain. If their altitude be different, so that the one may glide past the other, but in immediate contact with it, there will be a more considerable mingling of the two, but still not such as is commensurate with the effect observed. This hypothesis is besides encumbered with other difficulties. Where shall we find the cause or causes that shall set two currents in motion in opposite directions, and make them flow on amicably together, and in contact with each other for hundreds of miles? If they are of nearly equal coldness, no considerable effect will follow from their mixture. If they differ greatly in their temperature, their specific gravity will be so widely different that they will separate, the lighter flowing above, and the heavier below. If we suppose that combination of circumstances which, according to these views, would produce a condensation of the moisture of the atmosphere to happen occasionally; it could not, like the fall of rain or snow, be an every day occurrence. But if the air have commonly in storms a vertiginous motion, the difficulty vanishes at once. The warm strata at the surface will be carried upwards, and the cold strata brought down from above, and as perfect a mixture of air of very different temperatures produced, as any theory can demand.

Franklin draws his illustration of the movement of the air during our north-east storms, from that of the water in a canal, when the gate by which it had previously been confined is raised; and with his views those of Dr. Hare appear nearly to coincide. Dr. Hare appears to regard the warm moist air that rises from the surface of the Gulf of Mexico, as the repository from which the rain and snow are derived, the precipitation being caused partly by a diminution of capacity, undergone by it in consequence of its rarefaction as it ascends, and partly by its admixture with the under current of cold air that comes in from the north-east, whilst it flows itself from the south-west. The accuracy of these views may be questioned on a number of different grounds.

1. The precipitation arising from a change of capacity produced by rarefaction, must be confined to the immediate neighborhood of the gulf where the ascent and rarefaction take place. The rain and snow descending upon the middle and northern states must therefore be ascribed simply to the mixture of the lower surface or stratum of the upper current of warm air flowing *towards* the north-east, and the upper stratum of the current of cold air coming *from* that quarter.

2. The objection just stated to the doctrines of Mr. Leslie, as advanced in his illustrations of the Huttonian theory of rain, applies with great force here. The source of refrigeration is altogether inadequate to the production of the effect ascribed to it. Dr. Hare remarks that by every fall of snow, twice as much caloric is liberated as would be yielded by an equal weight of red hot powdered glass. But not only is the amount of rain or snow falling during a north-east storm very great, but the weather itself often becomes intensely cold. Let it now be supposed that the north-east current of air continues to move at the rate of thirty miles an hour, and the upper south-west current at the same rate in the opposite direction for twenty four hours. The average velocity of the wind during these storms never exceeds this estimate of forty four feet per second—probably it never reaches it. (See the different tables of the velocity of the wind.) The result will be simply that of bringing the air overhanging the eastern part of Maine, and that overhanging the south-western part of Georgia into contact with each other over the state of Maryland. The effect would be gradually produced, but the total amount would be the same throughout the whole length of the Atlantic coast with that arising from an instantaneous application of the under stratum of the air resting upon Maine, to the upper stratum of that resting upon Georgia. But this would be altogether inadequate to the determination of a fall of snow several inches in depth, and of weather at the same time intensely cold. It is also to be remarked that there is often almost a calm when the rain or snow commences. It is only gradually that the wind makes itself felt and rises to a gale.*

3. There are good reasons for doubting whether there be any considerable transfer of the air from the north-east towards the south-west during the prevalence of a north-east storm. Suppose a source of heat and rarefaction to exist over the gulf of Mexico; that the air overhanging it ascends; that the air of Georgia and the Carolinas comes in to supply its place, and the whole line of the Atlantic coast is affected by the drain established in the south-west quarter. We might look for the following results. The wind would be most violent in Georgia, and would continue to prevail there, until the cause of heat and rarefaction was removed from over the Gulf. In the States more remote, the wind would be feeble in proportion as the

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* See Dr. Mitchill's account of the north-east storm of February, 1803, in the Philosophical Magazine, Vol. XIII, p. 273.

distance was greater, and in Maine would hardly be felt at all. The storm would cease when the cause by which it was produced had ceased to act, and at nearly the same time throughout the whole tract of country swept by it. The simplest doctrines of equilibrium, as applied to elastic fluids, force these conclusions upon us. But the storm is found in fact to be as violent at the north as at the south. It proceeds, and is over in Georgia, and the sun is perhaps shining there at the time when it is exerting its utmost fury in Maine.

I can account for all the phenomena, only by supposing that a vortex or horizontal whirlwind, or rather a succession of them, is established in Georgia, and passes gradually over the United States. The existence of such a vortex, creating a wind from the north-east at the surface of the earth, is obviously not incompatible with an actual transfer of the whole body of the atmosphere, incumbent upon the United States *from the south-west.* It is probable, however, that the transfer is from the north-east. The warm air of the ocean, saturated with moisture, is in this way brought over the land; it is lifted by the vertiginous motion that has been created and propagated along the coast, into the upper regions of the atmosphere, and the intensely cold air of those regions brought down to the surface. It is believed that in this way, and in no other, we can account for the phenomena of our north-east storms.

During a nine days' passage from New York to the Capes of Virginia, in the summer of 1829, I had ample opportunity of observing the movements of the air during the prevalence of those light baffling breezes by which the ocean is occasionally swept in calm weather. The water is seen roughened by the wind in the direction from which it is afterwards found to blow as at C, every other part of the ocean, probably, except the tract immediately about C, being perfectly smooth. It is calm at A, beyond the place of the breeze, at B, the place of the vessel, and in the intermediate space at D. The roughness gradually approaches the vessel, reaches it, fills the sails for a moment, and passes by. How are these appearances to be accounted for? It is not a vacuum at B that urges the breeze forward, for that would set the air overhanging the whole intermediate space, that at D for instance, in motion, before there would be any movement at C. The effect is not produced by a portion of condensed

air, seeking to expand itself, as that would swell and escape equally in all directions. But upon the supposition of a vortex rolling over the surface of the ocean, the explanation is simple and easy.

The following statement, quoted by Daniell, from the "Account of the Arctic Regions," of a fact, apparently of common occurrence in those latitudes, places in a clear and strong light the unsatisfactory character of the views of the nature of the movement of the air during a wind, that are commonly taken. "Ships, within the circle of the horizon, may be seen enduring every variety of wind and weather at the same moment; some under close-reefed topsails, laboring under the force of a storm, some becalmed and tossing about by the violence of the waves, and others plying under gentle breezes, from quarters as diverse as the cardinal points." The same thing is witnessed near the equator, in that part of the Atlantic called the Rains. See the passage heretofore quoted from Halley. Two vortices, revolving either in the same or in different directions, may exist in the neighborhood of each other, and of a portion of air that is perfectly calm and motionless, but except upon the supposition of such vortices, these facts do not appear to admit of any explanation.

The phenomena of the common land and sea breezes are well known and easily accounted for. The land is more heated by the sun's rays during the day than the water; the air resting upon it is rarefied, and ascends, whilst that overhanging the sea comes in to supply its place: during the night, the land is more cooled than the water by radiation, and the movement is in the opposite direction. But the fact is not commonly adverted to, that these horizontal breezes must owe their existence to vortices of very moderate dimensions, which establish themselves around the shores where these breezes prevail, and revolve in opposite directions in different parts of the twenty-four hours.

"These winds" (the land breezes) "blow off to sea a greater or less distance, according as the coast lies more or less exposed to the sea winds, for in some places we find them brisk three or four leagues off shore, in other places not so many miles, and in some places they scarce peep without the rocks."——"These land winds are very cold, and though the sea-breezes are always much stronger, yet these are colder by far."*

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* Dampier's Voyages.

Now it is well known, that even within the limits of the trade winds, and in the seas where they blow with great violence, an alternation of land and sea breezes is experienced in islands of very moderate extent—in the Sandwich islands for example. Where does the land wind come from? The atmosphere overhanging the island would soon be exhausted. It must evidently be poured down from above, and its great coldness is at once accounted for. But it reaches an inconsiderable distance only, seaward; where does it go to? It must ascend, and having traced it through three-fourths of its entire route, the remaining quarter, which we cannot reach to observe it, may safely be inferred. When the sea breezes prevail, the motion is reversed, and probably also extends through a greater space. An ellipsis, whose longer diameter is parallel to the horizon, or some other figure of the kind, may be described.

Of the Causes of the Trade Winds.

With the above facts and arguments before us, we are prepared for an investigation of the proximate causes of the trade winds. Two theories have, as is well known, been advanced upon this subject. The earliest is contained in a paper of Dr. Halley's, read before the Royal Society in 1686. The other, that of Hadley, was brought forward in 1735, and as it is that which is generally adopted by the oldest philosophers of the present age, it may be regarded as presenting the strongest claim to our particular and continued attention. It may be stated in the words of Laplace.

"The sun, which we will suppose, for the sake of simplicity, in the plane of the equator, there rarefies by its heat the columns of air, and elevates them above their natural level; they should then re-descend by their weight, and be carried towards the poles in the superior part of the atmosphere; but at the same time a current of cool air should arrive from the climates near the poles, to replace that which has been rarefied at the equator. Thus two opposite currents of air are established, one in the inferior, the other in the superior part of the atmosphere. But the real velocity of the air, due to the rotation of the earth, is so much the less, as it is nearer the pole; it ought, therefore, in advancing towards the equator, to turn slower than the corresponding parts of the earth, and bodies placed at the terrestrial surface, should strike against it with the excess of their velocity, and experience by its reaction a resistance contrary to their

motion of rotation: thus, to an observer who thinks himself immovable, the wind seems to blow in a direction opposite to the rotation of the earth, that is, from west to east, which in fact is the direction of the trade winds."*

As Laplace speaks doubtingly of this theory, remarking merely respecting it, that it "*seems to be the most probable*," we may, without subjecting ourselves to the charge of overweening and unreasonable presumption, proceed to discuss its claims to accuracy, and state our objections to it—our objections to it as a full, complete, and satisfactory theory. The cause assigned by Laplace, has unquestionably a concurrent influence in the production of these winds.

The trade winds are here represented as a *secondary result* of the movement of the air overhanging the higher latitudes towards the equator, that movement being caused by the more elevated temperature of the tract towards which the current is directed. We are led to inquire why it is, that this current and the resulting wind are confined within the limits of thirty degrees on each side of the line. Why does not the air rush with as great velocity from the parallel of 60° towards that of 30°, as from the parallel of 30° towards the equator, and produce a trade wind within the former, as well as within the latter limits, especially as both of the causes upon which the trade winds are made by Hadley to depend, operate with greater energy in the higher than in the lower latitudes.

(*a.*) The first of these causes is the *excess* of the temperature of the equatorial regions over that of the countries lying nearer to the poles—of the tract under the equator, above that under the parallel of 30°. But the heat at the parallel of 30° exceeds that of the parallel of 60° more than it is itself exceeded by the heat at the equator. Both theory and observation lead us to this conclusion. See Halley's paper in the Philosophical Transactions, and Emerson's Miscellanies, for a mathematical determination of the amount of heat communicated by the sun's rays in different latitudes. Supposing the sun to remain on the equator, it varies as the cosine of the latitude. But the cosine diminishing more rapidly for a given number of degrees in the high than in the low latitudes, so must also the heat; or the mean temperature at 60° must differ more from that of 30° than this last does from that of the equator. With this agrees the remark of one who had ample opportunity for observation.

* Pond's Translation of the System of the World.

"Notwithstanding our advanced latitude, and its being the winter season, we had only begun for a few days past to feel a sensation of cold in the mornings and evenings. *This is a sign of the equal and lasting influence of the sun's heat at all seasons to thirty degrees on each side of the line, the disproportion is known to become very great after that.* This must be attributed almost entirely to the direction of the rays of the sun, independent of the bare distance, which is by no means equal to the effect."*

Professor Mayer, of Gottingen, undertook to deduce from a comparison of the meteorological observations, made in different latitudes, an empirical law for determining the mean temperature of different points in the earth's surface. He found this temperature to change very slowly in the neighborhood of both the equator and the pole, and rapidly in the intervening space. Thus the mean temperature under the equator he makes 84° 2′; at the parallel of thirty, 71° 1′; at sixty, 45°; the differences of which are 13° 1′ and 26° 1′. If his numbers are correct, it is apparent that the causes tending to create a movement of the air towards the equator, operate at the parallel of 60° with just about double the force they do at 30°.

(*b.*) When the air has once been set in motion by the more elevated temperature of the lower latitudes, the creation of a trade wind is determined by the increasing magnitude of the parallels over which it passes in its progress towards the equator, and the rapidity of the current flowing westward, will be greater in proportion as the differences in the circumferences of the successive parallels is greater. But these differences depending upon the differences of the cosines of the latitudes, must be greatest in the high latitudes; and supposing the movement of the air towards the equator to be the same as within the parallel of 30°, the trade winds should not only exist, but blow more violently there.

It appears therefore that both of the causes on which the trade winds are made by Hadley's theory to depend, operate with greater energy between the parallels of 30° and 60°, than within the actual limits of the trades, and yet fail of producing any wind. Not only is there no trade wind there, but there is in both the northern and southern hemispheres a decided predominance of winds from the west. It is generally regarded as a sound maxim in philosophy, that when

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* Cook's Voyage to the Pacific, 4to. Vol. iii. page 255.

a particular effect is attributed to the action of a certain cause; if on the reproduction of the cause, the effect fail to follow, we are to conclude that there was an error in the first instance, and that the original effect is to be traced to some other source.

An attempt is however made by some of the philosophers who reject altogether the theory of Halley, and embrace the views of Hadley, to account for the fact that the trade winds are limited by the 30th parallel, and that westerly winds prevail in the regions lying beyond it. It is said that the air which is rarified and ascends about the equator, flows off towards the poles,—that being cooled and condensed, it at length descends to the earth, and retaining its original velocity, moves eastward faster than the parallel over which it is incumbent, producing a wind from the west.* He (Mr. Daniell?) remarks that the restriction of the trade winds within the 30th degree of latitude, can be accounted for on no other hypothesis.—Not upon his principles. It may however be accounted for on different grounds.

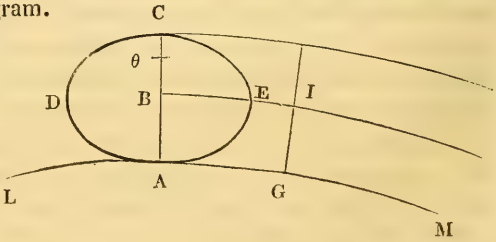
Now, according to this hypothesis, the westerly winds of the temperate zones are a secondary result of a current flowing from the equator towards the poles. They prevail *at the surface of the earth*, and can therefore be generated only by *a ground current, directed from the lower towards the higher latitudes.* For it will hardly be contended, that the air rushing towards the poles, might occupy the higher regions of the atmosphere, and communicate to the strata below, its motion eastward, without at the same time communicating its motion northward or southward. Is the existence of such a current probable? We have already seen that the causes by which the trade winds are produced, (according to the theory whose merits we are now endeavoring to estimate) act with less energy within the parallel of 30° than without it. Are we to embrace the opinion, nevertheless, that these causes produce the trade winds within the parallel, and also counteract the operation of stronger causes, and determine the movements of the atmosphere to the distance of 30° beyond, forcing back the air of the temperate zone, notwithstanding its tendency to approach the equator, into the neighborhood of the pole? This doctrine is very improbable, and has no evidence to support it. If there be an under current from the equator towards the poles, between the latitudes of 30° and 60°, the air that is transferred

* See Daniell's Meteorological Essays, p. 104.

by it must be returned from the poles through the upper regions of the atmosphere, and the circulation be carried on in a curve, returning twice into itself, or resembling a figure eight, placed horizontally, and bent so as to apply itself to the arc of a circle. But we are not left to argument and conjecture in the case. It has been already shown that within the limits specified, there is no predominance of winds directed from the equator towards the poles; the current is in the opposite direction. Of course, the westerly winds of the temperate zones cannot be produced by winds blowing from the equator; and the objection to Hadley's theory, drawn from the predominance of westerly winds, between the latitudes of 30° and 60°, remains unanswered, and it is believed unanswerable. Other objections may be found in the writings of Kirwan,* but it seems unnecessary to notice them.

The account of the origin and cause of the trade winds, given by Dr. Halley, was characterized by D'Alembert as obscure. Kirwan undertook to illustrate it, but does not appear to have been altogether successful. It seems to have been misunderstood by Playfair, by whom it is stated in the following terms:—"The cause usually assigned for the trade wind, is the constant motion toward the west of the spot to which the sun is vertical, and where of course the rarefaction is greatest. This, it is supposed, draws along with it the air from the east. This, however, is by no means a satisfactory explanation, etc."†

Halley's theory, as here presented, verges so closely on the absurd and ridiculous, that we cannot, without doing injustice to its very acute and able author, accept of it as a correct exhibition of his views—which receive illlustration from that part of his paper where he treats of the monsoons, and in the accurate conception of which we may derive aid from a diagram.



Let LAM be a part of the equator, or of an adjacent parallel of latitude, the spectator being on the north side of it. Let BIGA

* See Philosophical Magazine, Vol. xv. † Outlines, Vol. i, p. 307.

be the lower stratum of the atmosphere, three or four miles in thickness. Let the sun be vertical at A. The lower part of the column AC will be heated and expanded, and the portion Bθ lifted into the position θC, undergoing at the same time a slight condensation.* The portion θC will therefore have a tendency to flow over into the columns on each side of it. But it cannot flow in the direction CE, because the sun, moving in the direction AG at the rate of a thousand miles an hour, and carrying the point of greatest heat forward with the same velocity: before the part θC has time to yield to the impulse of elasticity and gravity, and flow into the columns west of it, they will themselves have been heated and expanded, and brought into the same condition with the column AC. It cannot flow either north or south, or at least its tendency to escape in those directions will be feeble, because all parts of the same meridian will be heated at the same time. There remains therefore only the direction CD. But the sun having already passed over the columns on the eastern side of AC, and they being cooled by radiation, and condensed, and θC being pressed on that side by a force less than its own elasticity, will expand itself, and create a current in that direction. The weight of AC being in this way diminished, and that of the columns on the east side of it increased, AC will rise, the air at the base of the columns east of it will flow in to supply its place, and a vortex be generated, moving westward below, and eastward above. A new impulse being given during each successive passage of the sun over the meridian, a permanent east wind will be created.†

Arguments will presently be adduced tending to render it probable that the motion of the air within the limits of the trade winds is actually of the kind here represented. In the mean time, it may be remarked that the above applies to such parallels of latitude only as

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* See remarks connected with Fig. 1.

† The Abbe Mann notices this expansion of the lower strata of the atmosphere, which he denominates a *heat tide*, in a paper copied into the Philosophical Magazine for Nov. 1799, but does not trace its effects in the generation of winds. It has this in common with the tide, that it accompanies the sun in his journey westward; but in regard to its cause, effects, and the manner in which the equilibrium that has been disturbed by it, is restored, it differs entirely. I have to regret that it has not been in my power to consult D'Alembert's "Recherches sur les causes general des Vents," of which, however, Playfair observes that it is more remarkable for the resource and ingenuity it displays in the management of the calculus, than for the physical conclusions to which it leads.

have the amount of heat communicated to the portions of air lying north and south of them nearly the same, or along which the point of greatest heat, or of a heat very little below the greatest may be supposed to travel from east to west. If the excess of heat on one side be moderately increased, the plane of the vortex will be inclined in that direction, but if the excess become considerable as through the greater part of the temperate zone, the equilibrium will be established in a totally different way. Thus with regard to the United States, the point of greatest heat first passes south of us, and an impulse is given to the under strata of the atmosphere in that direction, and when sometime afterwards the columns in the meridians west of us come to be expanded, the air that should have supplied the eastern or trade wind having passed off towards the equator, the upper or western current descends to the earth creating a westerly wind, or rather by the composition of motions in consequence of its mingling with the current that is proceeding southward, a north-west wind, which may be regarded as the *natural* wind of the parts of the globe lying on the north side of the equator beyond the 30th parallel. The same reasoning applies to the other hemisphere. As however the natural and gentle flow of the air in this direction is interrupted by evaporation, condensation and other causes, the result is simply a predominance in those latitudes of winds from the west, and the direction of the pole over those from the opposite quarters.

Two different causes therefore must exert an influence in the production of the trade winds. One is the permanent elevation of the temperature of the parallels lying near the equator over those more remote from it. Its action is indirect and most energetic in the northern parts of the temperate zone. The other is the diurnal increase of the temperature of the earth in all latitudes in consequence of the passage of the sun over the meridian. Its action is direct within the limit of the trades. That it is adequate to the creation of a considerable wind is proved by the fact that it is upon this that the other or permanent temperature depends, and that it is what determines the existence of two winds ; the land and sea breezes blowing in opposite directions every twenty four hours. By attending to the phenomena of the trade winds in different parts of the globe, we may form a tolerable conjecture respecting the one of the two causes which must be supposed to exert a predominant influence in the production of the total effect. In the immediate neighborhood of the equator, or at a small distance on the north side of it, the cause as-

signed by Halley, acts almost by itself, and the wind prevailing there appears to be from the east, but much less constant and violent than at some distance on either side. At those greater distances the two causes conspire, and a commensurate effect is observed. It is there that the trade winds rush onward with the greatest velocity. Between the latitudes of 30° and 60°, the two causes act in opposition; that assigned by Halley prevails, and there is a predominance of winds from the west.

That the trade winds are in fact produced by a circulation within their own limits, carried on by vortices in which the motion is westward below, and eastward above, is rendered probable by a number of separate considerations.

(*a.*) The definiteness of the boundary by which the trade winds are limited and separated from currents flowing in an opposite direction, and that they commence at once in full vigor at that boundary, are circumstances of great weight. "Thus in the northern Atlantic, from the same limits whence the north-east trade blows towards the equator, a south-west, (or rather west-south-west,) wind not uncommonly prevails in the contrary direction. So in the southern Atlantic, from the limits of the south-east trade, the prevalent winds are nearly converse, (west-north-west.) Now adverting to these winds blowing contrariwise from the same limit, there is difficulty to conceive the origin of either trade, but as derived from upper strata of the atmosphere, and if that source of supply at the commencement be acknowledged, there is little reason for rejecting it in the wind's subsequent progress." This author, however, attributes the trade winds to the "diminution of the air's specific gravity by absorption of moisture."*

(*b.*) In the Sandwich Islands, the trade wind blows from the north-east. Upon the summit of Mouna Kea,† in Hawaii, estimated to be more than eighteen thousand feet in height, Mr. Goodrich, in the

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* Colebrooke's Meteorological observations in a Voyage across the Atlantic, in Brande's Journal, Vol. xiv.

† The height of this mountain appears to be a matter of great uncertainty. It would be interesting to know whether the isothermal lines would strike it at the same height that they do Chimborazo. Circumstances might be mentioned which would have a tendency to depress, and others having a tendency to elevate them. In calculating its height from the condition of the mercury in the barometer on its summit, it is probable that the coefficient employed in Europe would be found inapplicable.

month of April, found a wind from the south-west resembling the cold blustering winds of March, in New England.* On the Peak of Teneriffe, Humboldt, Von Buch, and others, have encountered a raging west wind which scarcely allowed Humboldt to keep his feet. This was in summer. In the winter this west wind descends to the coast.† These facts show that the currents of the upper atmosphere are strictly counter currents, which carry eastward the air the trade winds have carried westward. They do not seem to be a mere result of motion of the air of the equatorial regions towards the pole, but of a gyratory movement in a vertical plane.

(*c.*) On Monday the 27th of April, 1812, the Souffrier mountain on the island of St. Vincent, after having remained dormant for more than a century, suddenly emitted a column of smoke which continued to increase in magnitude and density until Thursday, the 30th, when it was accompanied with an appearance of flames and an eruption of lava. On Friday, the 1st of May, the atmosphere of Barbadoes was darkened by clouds of volcanic sand and ashes, which descended upon the island to the depth of nearly three quarters of an inch. Barbadoes lies at the distance of from ninety to one hundred miles east of St. Vincent, and the trade wind blows so directly and violently from the former towards the latter island, that a passage from St. Vincent to Barbadoes, can be effected only by making a circuit of many hundred miles. Von Buch remarks that " by this striking occurrence, the returning current in the upper regions was proved, and with it the theory of the trade winds, for which we are indebted to Hadley, was become something more than conjecture.

It places the existence of the upper current beyond the reach of a doubt, but lends probability to the theory of Halley rather than to that of Hadley, which last supposes the upper current to be directed from the equator towards the poles. In the present instance its course was due east. It is well known that the under current is deflected from its course by islands and projecting shores, but it is not easy to see why Hadley's upper current should be similarly affected. I cannot help suspecting that a vortex had established itself with one extremity on Barbadoes, and the other on St. Vincent, and that the

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* See this Journal, Vol. xi, p. 4.

† See Von Buch on the climate of the Canary Islands, in Jameson's Journal for July, 1826.

ashes were whirled into the air at the latter or western extremity, and brought down to the surface at the eastern.*

(*d.*) "On the western coasts of both continents, a wind from the west prevails."† This passage is quoted from a work which, along with valuable matter, contains a share of inconclusive argument from facts incorrectly stated. These westerly winds are created by a cause, having a close resemblance to that to which the trade winds are ascribed by Halley. They are unquestionably movements of the air in vortices revolving eastward below, and westward above.‡ Their existence proves nothing absolutely, but lends a degree of probability to the accuracy of the views advanced in this paper. Why may not the eastern and western or trade winds resemble each other in their causes, effects, and all the circumstances of their progress.

(*e.*) The coolness and freshness of the air within the limits of the trades so much exceeding what might be expected from the latitude, is a proof that it is affected by currents flowing down from above, and altogether incompatible with the idea that they are ground currents of which the cold returning upper current flows off towards the poles. "Nothing equals the beauty and mildness of the equinoctial region on the ocean."§ "In these winds there is something so exhilarating that one with difficulty believes so much vapor exists as the hygrometer indicates."|| "The climate of these (the Sandwich) islands is far more cool than might be supposed, judging from their latitude."¶ He attributes the circumstance to the prevalence of the north-east trade winds.

(*f.*) The infrequency of rain within the limits of the trades is another proof of the mixture of the upper and lower strata of the air, by ascending and descending currents. Rain is produced by the sudden mixture of air of very different temperatures charged with moisture; effected, as there is good reason to believe, by the establishment of a vortex or horizontal whirlwind upon the spot where it

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* See for the above facts, Von Buch, in loc. cit. and Philosophical Mag. Vol. xl.

† Daniell's Meteorological Essays.

‡ See account of the land and sea breezes.

§ Humboldt; see also his remarks on the temperature of the air, which are too long to be extracted.

|| Caldcleugh's observations in Brazil and on the equator.

¶ Stewart's Journal.

falls. But the trade winds, keeping up a constant circulation and intermixture of the upper and lower strata, there is no opportunity for those sudden changes which produce rain. In accordance with what is here stated, it is observed that such tracts of the intertropical ocean, as from any cause are not swept by the regular trade winds, are subject to violent rain storms accompanied by lightning and wind. So long as the monsoons blow regularly in either direction, the same effect is produced by them in the same way as by the trade winds, but the period of their change is characterized by most violent storms.

The causes assigned, by Daniell, for the infrequency of rain within the limits of the trades, are strange and unsatisfactory. He remarks first, that it being then only that the aqueous vapor attains its highest elasticity and rises into the upper current of the atmosphere, it must flow off along with the equatorial wind into the temperate zones on either hand. Grant that it is so, we may answer; the language implies what is known to be a fact; that there is no deficiency of vapor within the limits of the trades; that the whole tract is in truth a great ocean of vapor; why is it not precipitated? why is there so little rain? Because, says the author, "the temperature being remarkably steady, seldom varying more than two or three degrees, precipitation can but seldom occur." But why this steadiness of temperature? Precipitation, evaporation, heat and cold, stand to each other in the relation of reciprocal cause and effect, which produce and re-produce each other in endless succession. Why are there not within the limits of the trades the vicissitudes of the regions beyond? To say that precipitation seldom occurs there, because the temperature is remarkably steady, is very little more than reasoning in a circle.

(*g.*) We seem to witness in the appearances described in the following extract from Humboldt's account of his voyage across the Atlantic in 1799, the effects of a succession of vortices moving westward over the ocean, creating a cloud by a mixture of the upper and lower strata of the atmosphere, and a breeze, by which the vessel was for a short time driven rapidly forward, and then subsiding into a calm.

"The wind fell gradually the farther we removed from the African coast; it was sometimes smooth water for several hours, and these short calms were regularly interrupted by electrical phenomena. Black thick clouds, with strong outlines, rose in the east, and

it seemed as if a squall would have forced us to hand our topsails; but the breeze freshened anew, there fell a few large drops of rain, and the storm was dispersed without our hearing any thunder."—— "It is by means of these squalls, which alternate with dead calms, that the passage from the Canary Islands to the Antilles or southern coasts of America, is made in the months of June and July."*

Other arguments of less weight might be added to the above, but if these fail of producing conviction, I have no great hope that the others would be regarded as satisfactory, and shall therefore omit them. These vortices may be supposed to be either stationary or moveable, regular or irregular, few in number, and having their horizontal much greater than their vertical diameter, or numerous, and rolling in rapid succession across the ocean. The points where there is either a remission of the breeze, or a calm, will of course mark the separation of an individual from that which succeeds it.

The theory here advocated, requires the prevalence in the latitude of the United States, of a westerly, or rather north-westerly wind, proceeding from the higher regions of the atmosphere. That westerly winds predominate over the easterly in both hemispheres, between the 30th and 60th parallels, is shewn in a preceding page. That the north-west winds of the United States, descend from the higher regions of the atmosphere, is proved by President Dwight, with his usual ability, in a passage copied from his travels, into the eighth volume of this Journal, to which the reader is referred. The progress of scientific discovery, and especially the discovery of the immense power of radiation to cool the surface of the earth, has deprived some of his arguments of a part of their value, but the weight and force of the greater number remain unimpaired.

Of the Causes of Thunderstorms.

From the foregoing principles, facts and arguments, and the conclusions we have derived from them, there flows a theory of thunderstorms, which is capable however of being established on independent evidence of its own. It has appeared that the effect of the daily passage of the sun is to create, some time after mid-day, but how long after we have no means of accurately determining, a current of

* Personal Narrative, Vol. ii, page 5.

air in the upper regions of the atmosphere, directed eastward and downward. If it meet in its descent with a stratum of moist air, such as is known to exist in the lower regions of the atmosphere on those *sultry* days when thunderstorms are to be expected, there will be a condensation of vapor, and the formation of a cloud. Into the partial vacuum thus created, there will be a more rapid rush from the upper regions of the atmosphere, and a vortex or horizontal whirlwind will be formed, which will move forward before the current to which it owes its existence, creating a wind by its gyratory motion, and a rain, by whirling the lower strata of the atmosphere aloft, and bringing down the higher strata to the ground. That the actual origin and progress of thunderstorms is as here stated, is rendered probable by the following facts and arguments.

(*a.*) We have already shewn by numerous quotations, that thunderstorms generally move from west to east in all parts of the world. See also the last number of this Journal, page 192, where it is stated that twenty-one thunderstorms, whose course has been distinctly traced in France, extended from N. N. W. to S. S. W., and that no destructive thunderstorm has come from any other points of the horizon. Within the limits of the United States, it is believed that these storms more frequently come from a point between west and north, than from a point between west and south. Both the wind that carries the cloud forward, and that which accompanies it, and seems to be more intimately connected with it, come ordinarily in the same direction. We cannot therefore attribute the effects observed to a wind coming from the north, or from the south, or from both of these points together, or to a wind coming from any other quarter than the west. If the fact of their coming from the west is not particularly and distinctly noticed in our theory, it is defective, and if the supposition of their being produced by winds blowing from any other point, be involved in it, it is erroneous. They are commonly succeeded by a cool breeze from the north-west, and are therefore the first burst of a wind that is to blow from that quarter for a number of hours.

(*b.*) Thunderstorms are produced, *in the first instance*, by a wind proceeding from the higher regions of the atmosphere. For, coming from the west, it is only a wind proceeding from the *higher* regions of the atmosphere, that will be cold enough to determine even the commencement of the precipitation, that is an essential part of these storms. The generating and attendant wind are apparently of the same nature, and have the same origin with the north-western

breeze that succeeds them, and this President Dwight has shown to descend from the higher regions of the atmosphere.

(*c.*) It has been shown that in all parts of the world, thunderstorms generally commence in the after part of the day. They have therefore some close and intimate connexion with the transit of the sun, either over the meridian under which they occur, or over one at some distance west of it. Their occurrence in a particular part of the day, proves the very powerful action of the cause to which the trade winds are attributed by Halley, and that the sun in his daily passage excites a great commotion in the atmosphere, and creates a current in the air moving from west to east.

(*d.*) Thunderstorms are strictly local phenomena. One of the greatest errors of those who have investigated the motion of the winds, has been that of attributing those prevailing in the particular country where they made their observations, or to which their remarks applied, to general currents, traversing extensive tracts of the earth's surface. Thus Kirwan represents the south winds, which prevail in England in the winter season, as part and parcel of a great current, which, sweeping by the north pole, passes at length down the eastern side of Asia, between the coast of Malabar and the Moluccas to the equator. If winds in general, and especially those bringing rain, were not local, there would not be the wide difference actually observed, between different parts of the earth's surface in regard to dryness and humidity. We should have no burning desarts of Sahara. But a glance at a collection of tables where the direction of the winds in places not very remote from each other, is exhibited, is sufficient to satisfy any one that they are the result of local causes.

The water recently drawn from a well in New Haven on a hot summer day, is poured into a tumbler; dew is seen to be deposited upon the outer surface of the tumbler; a coming storm is foretold, and the prediction is commonly verified. Its existence in that particular place, and at that time, is determined by what happens to be the condition of the air in regard to warmth and moisture there. When it comes on, the limits and route of the cloud are perfectly defined. The cause therefore of the storm, its progress and effects, are local, and have nothing to do with distant regions.

(*e.*) The wind which precedes and accompanies a thunderstorm, has a vertiginous motion, and brings the masses of hot and cold air into a state of intimate mixture, by a process that has already been

very fully explained. This position is established and illustrated by the five following arguments.

1. The progress of the wind during a thunderstorm is commonly much more rapid than that of the storm itself. The cloud and rain move at the rate of not more than eight or ten miles an hour, whilst the wind is blowing at the rate of thirty, prostrating often forests, as well as the structures erected by man, as it advances. It is perfectly calm before the storm, and if there be any wind, it is but a gentle breaze on each side of it and behind it. Where does this rapid current come from, if not from above, and whither does it go, if it is not again whirled aloft. The cool lateral breeze, that is sometimes felt in the neighborhood of a cloud, may be, and probably is, the effect of the lateral communication of motion from the falling drops to the air through which they pass, resembling therefore in its origin the current of air by which the blast is maintained in the forges of North Carolina; but the violent wind, blowing in the direction in which the cloud moves, cannot be accounted for in this way.

2. Aeronauts select a calm clear day for their voyage, and do not launch their car into the bosom of a thundercloud. From the histories of the persons engaged in this kind of navigation, to which I have access, and which are not very numerous, I have been able to collect only the following facts having a bearing upon the question before us. A Mr. Crosbie, who ascended from Dublin, in July, 1785, entered a thick cloud, and strong blasts of wind, with thunder and lightning, which brought him rapidly towards the surface of the water. M. Blanchard, ascending from Strasburg, on the 26th of August, 1787, in "horrible" weather, let off a parachute with a dog attached to it, at an elevation of a little more than a mile, which, instead of descending, was carried by a whirlwind above the clouds. Blanchard afterwards fell in with the dog again in the course of his voyage. He was bending his course directly downwards, but presently lifted by another whirlwind to a great height.

The ascending and descending currents, to which the phenomena of storms are attributed in this paper, do not therefore rest on mere hypothesis, but have as much direct and positive evidence of their existence, as the case seems to admit. The curvature of the circle or ellipsis, in which the wind is supposed to revolve, is so small, that its power of raising bodies from the earth must be extremely feeble, yet it were an easy matter to collect from the Philosohical Transac-

tions, magazines and newspapers, vast numbers of different accounts of various substances having been carried to a distance by the wind, whose transportation can be accounted for on no other supposition than that of its vertiginous motion. Salt storms, in the neighborhood of the sea, present no difficulty, if such a motion be admitted.*

3. If the wind accompanying a thunderstorm, have a vertiginous motion, the cause is apparent, of the coldness of the air during its continuance, and after it; of the condensation of the vapor and the descent of hail. Thunder is popularly said to cool the air and purify it—and no wonder, if it be attended with a thorough and intimate mixture of the upper and lower strata of the atmosphere. The coming on of a thunderstorm in New Haven is commonly determined by the condition of the lower strata of the atmosphere in that place—the warmth and moisture of the air, or, in other words, the sultriness of the day. It is a portion of the same vapor that gathers upon the outside of a tumbler, that afterwards descends in rain or hail. How is it condensed and frozen? Plainly it must either be raised itself into the region of eternal frost, or the air of that region must be brought down to it, or both. We also see clearly why, except amongst the mountains, there are no hailstorms in the equatorial regions. The term of perpetual congelation is at such a distance from the surface of the earth in those latitudes, that the gyratory movement does not extend far enough into it, to produce any thing more than the condensation of the vapor into drops of rain. We also get clear of the difficulty of forming such vast hailstones as are sometimes known to descend, and of which it is difficult to conceive how they can be generated during the simple fall of the original nucleus to the ground. A nucleus may be first frozen. It may then be hurried aloft, like Blanchard's dog, or the volcanic ashes of St. Vincent, and maintained in the air, till, by continued accretions, it has grown to the size observed. Their occasional slowness of descent may arise, *in part*, from their encountering an ascending current of air. They sometimes fall rapidly.† The hailstones were from the size of pigeons' eggs to the weight of three ounces, with a circumference of seven inches. "When they struck the ground, they would rebound to the height of ten or twelve feet, and pass twenty or thirty before

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* See Dr. Beck's paper in the first Volume of this Journal.

† See Lewis & Clarke's Travels, Appendix, under date of June 27, 1805.

they touched again. The men saved themselves, some by getting under a canoe, others by putting sundry articles on their heads; two were knocked down, and seven had their legs and thighs much bruised." Capt. Lewis remarks, under April 1, "*I have observed that all thunderclouds, in the western part of the continent, proceed from the westerly quarter, as they do in the Atlantic States.*"

4. Adopting the views of the phenomena of thunderstorms, taken in this paper, we shall find no difficulty in receiving as true and accurate, the well attested, but hitherto inexplicable, accounts of the effect of the surface of the ground over which they pass, upon their progress and direction; that they should turn aside from their path, to follow the course of a stream, or to avoid a forest or rising ground; that these last should check their progress,* or that one storm should show a disposition to advance in the track of its predecessor, where of course the air is more highly charged with aqueous vapor. How is it, we have been ready to inquire, that the earth can exert this kind of influence upon the clouds hovering over its surface? Is it some unknown attraction or repulsion? But it is well known that straits, valleys and defiles, in the mountains, change the direction of winds. It is evident therefore, that they may exert an influence upon the lower rim of a revolving current, where it touches the earth, and change the direction of its plane, or retard its progress.

5. Finally, it may be of advantage to recur once more to our original and fundamental proposition respecting the cause of winds—*that they are in all cases the secondary result of a movement, or rather of two movements, the one upwards, and the other downwards, in a vertical plane, and that they are accompanied by a counter-current in the upper regions of the atmosphere.* They can be generated in no other way, nor can they continue for any length of time after the vertical motion has ceased. If the horizontal current is rapid and violent, the same must be true of the vertical. If the requisite number of points in its track were ascertained, we might determine its whole route in the same way, though not with the same degree of accuracy that we investigate and ascertain the orbit of any other revolving body. Whereas, in the case of a thunderstorm, the space covered by the tempest is small, and the path of the wind is a tangent to the earth's surface through a small distance only; no inference in Phys-

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* See the last Number of this Journal.

ics is more immediately derived from the simplest and clearest principles, than that there must be a descending and ascending current, moving with the same rapidity at its extremities. These vertical currents are not to be regarded as effects, but *causes*, of the horizontal one. They are first in the order of causation, and the horizontal current could not exist without them.

No notice is taken here of the anomalies with which this department of nature abounds, beyond every other. Causes analogous to those which produce thunderstorms from the western quarter, and in the after part of the day, in most countries, will bring them on at other hours, and from other points of the compass, at particular times and in particular places. It is suggested, however, that conclusions, drawn immediately from the first principles of the equilibrium and movement of elastic fluids, and whose accuracy is rendered probable by their explaining a great number of phenomena, are not to be regarded in the light of a mere hypothesis.

Of the Peculiarities of the Climate of North America.

The climate of North America, or rather of that part of it lying east of the Rocky Mountains, when compared with that of Europe under the same parallels, is found to differ from it remarkably in two particulars.

1. The mean temperature is several degrees lower.
2. The vicissitudes of temperature are much greater.

The first settlers of North America found that they experienced a cold in winter much more severe than they had been accustomed to in their native country, and drew the inference that the western continent is much colder on the same parallels, than the eastern. But they found also that the American is hotter than the European summer; and as there had been no accurate observations for determining the mean temperature, philosophers ventured on the adoption of the opinion that it is much the same on both sides of the Atlantic, and that the two continents differ only in the extent and suddenness of the vicissitudes to which they are liable. This opinion is still entertained and defended by Mr. Leslie.

"The extremes of summer and winter probably differ more in America than in the old continent; but the mere (mean?) temperature on every parallel appears, when carefully taken, to be nearly the same."*

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* Supp. to Encyclopedia Brittanica, Art. CLIMATE.

There is no room for doubt, however, at the present day, that the mean temperature of the part of North America, lying east of the Rocky Mountains, is several degrees lower than that of Europe under the same parallels. The paper of Dr. Lovell, in the twelfth Volume of this Journal, is altogether decisive of this point, and, with the results furnished by him, and those obtained by other observers, agree, as might be shown at length, if it were necessary. It appears that in the higher latitudes, as at Stockholden, (lat. 59° 20′) in Europe, the mean temperature corresponds to that of a place about 14½° farther south, on the eastern coast of America; in latitude 50°, it corresponds to that of a place 8 or 10° farther south. The mean temperature of London, lat. 51° 31′, is 49.5; that of New Haven, lat. 41° 18′, as given by Professor Olmsted, for the years 1827, 1828, is 49.29, and 52.50. *About the latitude* 30°, *the mean temperature becomes nearly the same in both continents.* Thus at Grand Cairo and St. Augustine, in latitudes 30° and 29° 50′, it is 73. and 72.23.* This is an important fact, and accords very accurately with the theory of the cause of these peculiarities that is presently to be stated.

Two things are therefore to be accounted for—the low mean temperature of the eastern part of North America, and the great vicissitudes in its temperature. The two are sometimes confounded in the writings that treat of our climate, and sometimes one of them is overlooked or neglected. In remarking on the article of vicissitudes also, we must notice both the wideness of the interval between the general winter and summer range of the thermometer, and those changes which take place within the compass of a few hours.

The forests by which the whole country was covered when our ancestors landed on these shores, and which have not yet disappeared, the immense lakes that occupy its interior, its mountains, the proximity of the great northern ocean, its elevation above the bed of the sea, and certain salts supposed to exist in the air, have been by turns assigned as the causes of the climate of North America. Dr. Halley could account for its extreme coldness in no other way, than by supposing that the pole of the world was at some remote period within the limits of this continent, about Hudson's Bay, and afterwards shifted into its present position, and that this quarter of the globe has not yet acquired the temperature due to its latitude.

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* See Dr. Lovell's table.

But that the great efficient causes of these peculiarities, are to be found neither in its forests, lakes, mountains, nor polar seas, is proved by the fact, that they are almost as strongly marked in the territory of Arkansaw, as about Hudson's Bay, though the cold winds which sweep over the former country, and determine its climate, come from the bare and arid plains that are spread out for hundreds of miles at the base of the Rocky Mountains. That these causes are not confined to the eastern part of this continent, is rendered certain by the circumstance, that a climate, having the same characteristics with our own, prevails in the northern part of China, and apparently throughout the whole of the eastern part of Asia, lying beyond the limit of the trade winds.

"The extremes of heat and cold are much greater at Pekin than at Madrid, though the latitude is much the same; it freezes daily in December, January and February, and very often in March and November. The cold is often followed by excessive heat—the medium heat of the year is 55°." "It is said that Corea, though in the latitude of Italy, has a very cold climate, from the mountains which it contains." "Tussilagos, and the Kamstchatkan lily, thrive in it, (Jesso, lat. 43°) shewing that the climate is moist and cold." "The intelligence of these poor islanders (Leghalien, lat. 50°) struggles against a severe climate."*

With the same latitude on the continent of Europe, instead of 55°, Pekin would have a mean temperature of 62° 7′. If therefore we would assign the true cause of the peculiarities of the climate of our own country, we must discover one which is common to the eastern part of both continents. Daniell seems at first sight to have fulfilled this condition in the happiest manner.

"It is explained by the heat evolved in the condensation of vapor, swept from the surface of the ocean by the western winds. This general current, in its passage over the land, deposits more and more of its aqueous particles, and by the time that it arrives upon eastern coasts is extremely dry: as it moves forward, it bears before it the humid atmosphere of the intermediate seas, and arrives upon the opposite shores in a state of saturation. Great part of the vapor is there at once precipitated, and the temperature of the climate raised by the evolution of its latent heat."†

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* Malte Brun's Geography, in various places.

† Meteorological Essays, p. 105.

But the excellence of this solution of the difficulty, depends simply upon its being an inaccurate statement of facts, to which, if the necessary correction be applied, it becomes altogether worthless. The precipitation is greater on the western than on the eastern side of the Atlantic. Mr. Dalton makes the mean average of rain falling in England, 31.3 inches, and the precipitation of moisture, including frost and dew, 36 inches. At Paris it is 20.2, Rome 21.3, London 23, Padua 34.5, Pisa 43.2. At Andover, in Massachusetts, it is from 48 to 52 inches; at New Haven, (Connecticut,) 44; at Chapel Hill, (North Carolina,) 44; and at Charleston, (South Carolina,) it is 50.9. In general, in the whole of the eastern part of North America, it appears to be above 40 inches.* The quantity of rain falling on the western coast of America, if we may judge from the experience of Messrs. Lewis & Clarke, in the winter of 1805-6, is very great, but so it is in China. The Jesuit Cibot wrote from there on the 20th of October, 1761, that more than five French feet, and of course more than 64 English inches of rain had fallen in that country during the past *summer*. That was a disastrous year, and the quantity of rain unusual; but the case is one to which the "Hercules ex pede" is applicable. If there be any excess of precipitation on the western coast of America over that of the eastern coast of Asia, it is probably altogether too small to account for the difference of temperature.†

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* See Dr. Thomas Young's Philosophy, Vol. ii, p. 277; President Dwight's Travels, Vol. i. p. 82; and this Journal, Vol. xvi, p. 74. The number for Chapel Hill, (accurately 43.865 inches) is the mean result of a register, kept by President Caldwell, of this University, for six years, and extending from the 24th of July, 1819, to the 24th of July, 1825. The greatest amount of rain falling in a year, thus limited, was 64.2 inches; the least, 31.4.

† I have sometimes suspected that the winter, when Lewis & Clarke were on the western coast, was peculiar, or that the weather and winds they experienced, depended upon their position at the mouth of a large river. Almost the only winds they had were from the north-east and south-west; the former being dry and accompanied by clear weather, and the latter by deluges of rain. Capt. Cook agrees with them in regard to the mildness of the climate, but appears to have often had the wind from the north-west. Though a sea wind, it had the same characteristics, and was accompanied by the same weather as in the United States. "The weather, during our stay, (at Nootka Sound,) corresponded pretty nearly with that which we had experienced off the coast: that is, when the wind was any where between north and west, the weather was fine and clear, but if to the southward of west, hazy, with rain. The climate, as far as we had any experience of it, is infinitely milder than on the east coast of America, in the same latitude."—*Cook's Voyage*, Vol. ii, p. 290.

The low mean temperature of the eastern coasts of Asia and N. America remains therefore unaccounted for. Prest. Dwight's argument respecting our north-west winds, by which he proves that they descend from the higher regions of the atmosphere, although ingenious and able, does not reach the exigencies of the case, because the question still arises, "Why is not Europe infested with the same winds, or with winds from some other quarter, having similar characters?" The central fire of some philosophers occurs to the mind as the probable cause of the difference, and the idea is suggested that the walls of the great interior furnace are thicker on the eastern shores of Asia and America than elsewhere. But it seems unphilosophical to assign for a known effect a cause, whose existence even is regarded by many as problematical, and which we can never *prove* to operate in the manner we suppose.

The Rocky Mountains appear to constitute the boundary by which the cold is separated from the mild and temperate part of North America. "I am confident (says Capt. Lewis) that the climate here (at the mouth of the Columbia,) is much warmer than in the same parallel of latitude on the Atlantic ocean, though how many degrees it is now out of my power to determine." The amelioration of the climate seems to be very sensibly felt as soon as the great ridge is passed. "It was impossible to avoid remarking the great superiority of climate on the western side of that lofty range. From the instant the descent towards the Pacific commences, there is a visible improvement in the growth of timber, and the variety of forest trees greatly increases."*

Our attention is therefore drawn to these mountains, as probably in some way the *cause* of the diversity of temperature that is observed on their opposite sides, and the following may be the true reason of the low mean temperature of the eastern part of North America.

The Rocky Mountains, stretch from the table land of Mexico, into the immediate vicinity of the polar sea. Throughout their whole extent, they nowhere descend much below the region of perpetual congelation, and in many places they ascend far into it.

(*a.*) Some gentlemen attached to Major Long's expedition, ascended James' Peak, lat. 39° 23′, and give the following account

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* Drummond, in Franklin's Narrative, p. 256.

of the view from its summit on the 14th of July, 1820. "From the summit of the peak, the view towards the north, west and southwest is diversified with innumerable mountains, all white with snow, and on some of the more distant it appears to extend down to their bases." These high ridges extend down as far as Santa Fe, lat. 36° and there are good reasons for believing, that there are others still more elevated west of that town, and of the sources of the Rio del Norte.

(*b.*) Lewis and Clarke crossed at a gap or low place in the ridge, at the head of the Missouri, and between the latitudes of 43° 30′ and 46° 41′, were surrounded on every side by mountains covered with snow, between the 12th of August and 9th of September; they also travelled over deep snow on their return in the last days of June.

(*c.*) Mackenzie crossed in latitude 52° 6′. Notices of mountains covered with ice and snow, occur in his Journal, under the dates of May 26; June 5, 12; July 17, 27 and August 13, 17. He appears also to have crossed at a gap.

(*d.*) The northern extremity of these mountains, lat. 70°, was seen by Capt. Franklin, covered with snow in the beginning of August. The accounts obtained of intermediate points, are such as to create a belief that they are still more elevated.

Over this lofty barrier, a cause as constant as the revolution of the sun, is urging the air from the west and (if the views taken in this communication of the specific manner in which this cause operates are correct) urging especially, the upper strata of the atmosphere. But however this may be, it is at least certain, that only the upper strata can pass. I may add that the lower strata *do not* pass, for if they did they would melt the snow. The air which has had a mild temperature, communicated to it on the bosom of the Pacific, is stopped and a deluge of air having a temperature never elevated much above 32°, and often depressed very far below it, is poured over upon the region on the east side of the mountains, from the icy sea, quite down to Mexico. This air imbibes heat from the soil of the eastern part of the continent, and continuing its course, carries it off over the Atlantic. This country therefore communicating heat to the prevailing winds, and receiving none from them, has its temperature depressed. This cold deluge must exist and produce the effects ascribed to it, unless a law of nature, which we have shewn to obtain in other parts of the globe, is arrested in the case of North America. Its existence is also proved by observations, made in the immediate

neighborhood of the mountains, where westerly winds are found to have a greater predominance than in the regions farther east.*

This then is a particular, in which the eastern side of N. America, differs widely from the western coast of both America and Europe, and the person who has witnessed the change of temperature, produced by our N. West winds, in a single night, or read of the effects of certain winds in other countries, of the Sirocco for instance, in Italy, will not be disposed to deny, that it is fully adequate to the production of the low medium temperature of North America. The vast elevated plateaus, and enormous ridges of Central Asia, stand in the same relation to China, that the Rocky Mountains do to the United States. It is stated that the greatest cold experienced at Pekin, occurred during the prevalence of a wind from the north-west. In Japan "in winter the north and north-west winds are exceedingly sharp, and bring along with them an intense frost." Malte Brun. It is to be particularly remarked, that the peculiarities of our climate, cease in latitude 30°, where the westerly winds are limited on the south. St. Augustine and Grand Cairo have very nearly the same mean temperature.

The great vicissitudes of our climate, are due to a cause nearly related to that which has just been assigned for its low mean temperature—*to the fact, that our predominant winds are from the west, and therefore trade winds.* Any country whose predominant winds come from over the land, will be subject to great vicissitudes of temperature. China and the United States agree in this particular.

The account commonly given of the origin of the land and sea breezes, may serve for illustration. The land, it is said, is more intensely heated than the water by the sun during the day, and the sea breeze prevails; it radiates more during the night, and the movement is in the contrary direction. Now suppose two places to be so situated, as to be subject to a constant breeze but the one to a breeze reaching it after traversing an extensive tract of land, the other from over an equal expanse of water. There can be no doubt that the latter would enjoy the most uniform temperature. The place where the land breeze prevailed, would be hotter in the day and colder at night. But what is here supposed and stated, respecting places of limited extent, such as a city or county, and different hours of the

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* See Lewis and Clarke's register of the winds during the winter of 1804–5, and Franklin's Narrative.

day, will hold good for large tracts of the earth's surface, and different portions of the year. Land is more rapidly and powerfully heated than water, by the rays of the sun during the summer, and more rapidly cooled by radiation during the winter; consequently a country whose predominant winds, come from over the land, such as the eastern parts of Asia and North America, will have hot summers, and winters intensely cold. The following extract from Russel's Natural History of Aleppo, may be given as an additional proof and illustration.

"The coldest winds in the winter, are those that blow from between the N. West and the East, and the nearer they approach to the last mentioned point, the colder they are during the winter and part of the spring; but from the beginning of May to the end of September, the winds blowing from the very same points, bring with them a degree and kind of heat, which one would imagine came out of an oven, and which, when it blows hard, will affect metals within the house, such as locks of room doors, nearly as much as if they had been exposed to the sun."*

It is easy to see what the climate of Aleppo would be, if this east wind were to blow constantly, or even to predominate, and on looking at the map, we see the reason of its peculiar characteristics. It is preeminently a land wind. It is for a similar reason, that in the United States, where the predominant winds are from the west, the winter is excessively cold, and the summer as intensely warm.

A little attention to the causes, which conspire to produce our coldest winter and hottest summer weather, will lead to an explanation of the suddenness of those changes of temperature, which often take place within the space of a few hours. Our coldest weather is, when the wind is somewhere between the west and north-west, and depends upon the following concurrent causes.

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* Dr. Adam Clarke, commenting upon this passage from Russel, but with reference to a part not quoted above, in which the debilitating effects of this east wind are spoken of, remarks—"A gentleman who lived long in the east, gives rather a different account—I was at Madras many years, where this wind prevails in the hot season, and the effect it had on me, was extremely pleasant; I was always in better health." The case places in a strong and clear light, the importance of the union of philosophy with learning to the formation of an accomplished scholar. What could the wind, coming to Madras from the east, over the *Bay of Bengal*, be expected to have, in common with an east wind at Aleppo?

1. The wind itself descends in part from the higher regions of the atmosphere, and in part pours, with a temperature below 32°, over the Rocky Mountains.

2. It is therefore extremely dry, and creates a brisk evaporation, with a depression of temperature, through the absorption of latent heat, by the vapor that is produced wherever it meets with water in its passage.

3. For the same reason—its extreme dryness—it brings no clouds with it, nor except when it first bursts down upon the air, previously resting upon the country east of the mountains, does it create any. It is part of the great circulation, and has not, therefore, that vertiginous motion, on a comparatively small scale, upon which the formation of clouds depends. The sky becomes of a deep blue, and the radiation is immense. Is it wonderful, that under these circumstances, the mercury in the thermometer should suffer a great depression—that the country west of Hudson's Bay, should be in winter, perhaps, the coldest part of the world?

The west winds of summer are, like those of winter, originally cold, and frequently continue so till they reach the Atlantic States; but when their velocity is small, passing over tracts of land intensely heated by the sun's rays, they sometimes acquire the burning temperature of the torrid zone.

The sudden changes, complained of in the climate of North America, are almost exclusively changes from heat to cold. We have a warm day; the wind comes round to the north-west at night, and by the next morning the earth, which was a mass of soft mortar in the roads, has acquired the solidity of a rock. The reason of the difference that obtains between this country and Europe, in regard to the suddenness and frequency of changes of temperature is, that no where, except on the eastern coasts of America and Asia, can powerful causes, such as those mentioned above, as concurring to produce our coldest winter weather, be brought to exert their combined action as suddenly and as frequently. The cold—bringing north-west winds, are the natural winds of the country, which, after vibrating through other quarters of the compass, show a constant tendency to settle on that point. Here, as before, all depends upon our position and predominant winds.

If the views taken in this paper are correct, and its arguments sound, the peculiarities of our climate depend upon three things—the prevalence of westerly winds between the latitudes of 30° and

60°; the existence of a lofty and unbroken chain of mountains, between us and the Pacific; and finally, upon our position on the eastern instead of the western side of the continent. It has been supposed by some, that our climate will be greatly improved, when the country shall have become, to a more considerable extent, disforested. The progress of cultivation may have some influence upon it, but it must be remembered that the climate of China, the most densely populous country in the world, continues to bear an intimate resemblance to our own, and it is strongly suspected, that unless the direction of the great aerial currents, that traverse the surface of the earth, shall be permanently changed, the Rocky Mountains melted away, or the territory of the United States transferred to the western side of them, our climate will be much the same a thousand years hence that it is now.

Art. VII.—*Observations and Experiments on the rapid production of Steam in contact with metals at a high temperature;* by Walter R. Johnson, Professor of Mechanics and Natural Philosophy in the Franklin Institute, Philadelphia.

To account for the sudden explosions which sometimes occur in steam boilers, one hypothesis assumes that the metal, by undue exposure to the fire, and by a deficiency in the supply of water, becomes intensely heated and thereby affords a *source of heat* ready to act with great rapidity on any new portion of water which may be injected, or otherwise brought into contact with the heated surface. Whether the water be thrown up by ebullition, or caused to flow over the hot part of the boiler, by some *change in the position* of the latter, will be of little consequence to the result so long as we are sure of the presence of the dangerous generator.

The construction of many steam boats, or rather the arrangement of their boilers, favors the presumption that a mere change of position has sometimes caused an explosion of the nature now alluded to.

In the boats which navigate our western waters, eight or nine boilers of a cylindrical form, thirty inches in diameter, and about fourteen feet long, are laid side by side lengthwise of the boat, so that, allowing for interstices, from twenty two to thirty feet of the breadth of the deck, are taken up by the aggregate diameters of the row of boilers. They are almost uniformly constructed with *returning flues* from nine to twelve inches in diameter.

The flue being placed eccentric, with respect to the main cylinder of the boiler, and indeed wholly below its center, will be entirely immersed when the boiler is half filled with water. The furnace being at one end, the flame passes along the whole length of the boiler on the outside, and then entering the flue returns to a chimney near the upper or *fire* end. The boilers are all connected together by a pipe forming a water communication at bottom, and by another, forming a common steam passage above their upper surfaces. The lower gauge cock is placed from one to three inches above the top of the flue; and so long as the deck remains perfectly horizontal, and the forcing pump for injecting water performs its office, a moderate degree of care, on the part of firemen and engineers, may insure the complete immersion of the flue. But when from any cause, the boat inclines to either side, there will be a transfer of water through the lower connecting pipe from the boilers on the elevated, to those on the depressed side of the deck. A large number of passengers collecting on one side would doubtless be sufficient to cause a "heeling" of a foot or more, and this would lay bare the whole of the flue in the upper boiler, and expose more or less surface of iron in every flue and boiler on the elevated side. Every pound of water thus transferred, serves to increase by double its own weight, the tendency of the boat to *careen*, and even after the other causes of unequal depression have ceased to act, the water thus displaced will continue its influence, and will not until after sometime, return to its former level through the pipe of communication. The removal of water from the part of the usual generating surface of metal, will cause the supply of steam to be diminished, so that the *engine* may appear to labor, even while the boiler is becoming red hot. This circumstance, is known to have preceded some of the most frightful explosions, and it is but the natural result of employing that caloric which ought to be producing steam, in merely raising the temperature of metal, with the incidental effects of heating the steam already generated, considerably above the temperature which belong to its actual *density*. Not only must those parts of the boilers and flues which are immediately exposed to the fire, become unduly heated, but, owing to the high conducting power of the metal, the upper arch of the cylinder, as well as the lower, will rapidly acquire the temperature due to the source of heat. Some may possibly imagine that since the engine moves slowly for a time in consequence of a deficiency of generating surface, it will only move with

the more speed when the accumulated force comes to be added to the regular supply. This might be the case if the excess were furnished with no greater *rapidity* than the deficiency had occurred. But whether we suppose the hot steam, or the hot metal, to furnish heat of elasticity to the water which flows into the over heated boilers, the supply will be obtained almost instantaneously;—a few seconds, at most, being required to complete the operation of generating, from water of a boiling temperature, all the steam which the iron of the boiler, even when red hot, is capable of producing. In order to determine with some precision, what effect will actually be produced by the metal in such cases, I have performed a series of experiments tending to show the relation between the quantity of steam generated, the weight of the metal, the surface exposed, the time of action and the period of greatest effect. The trials have not been confined to rolled iron alone, but as the results must obviously be effected by the *specific caloric* of the metal, I have extended them also to wrought iron in masses, to cast iron, copper, brass, silver and gold.

These experiments were, in part, performed during the months of July and August last, when the temperature of the room seldom fell below 80°. This circumstance may, in addition to the other precautions to avoid error in the results, assure us that the change of temperature in the water, between two consecutive experiments, cannot at any time have been sufficient to affect the *quantity* of vapor generated, or the *time* employed in its production. In order to exhibit an approximation to the actual state of the boiler, when in a condition to receive hot water on intensely heated metal, and when, of course, the whole excess of caloric would be employed in giving the elastic form, and none in raising temperature, I procured a cylindrical vessel of tinned iron $19\frac{1}{4}$ inches deep, $7\frac{2}{10}$ inches in diameter, and capable of containing $28\frac{5}{16}$ lbs. of water at 60°. This was furnished with a cover of the same material, and with a wire handle like that of a bucket, for the convenience of suspending it to the beam of a pair of scales. The sides and bottom were covered externally with four successive folds of stout green baize, between each two of which was a *batting* of raw cotton, forming all together a coat of an inch thick. The non-conducting character of this defence may be inferred from the fact that fourteen pounds of water, left in the vessel for fourteen hours, was cooled only from 212° to 115° or about 7° per hour, while the temperature of the apartment was at 80°; and that in the following twenty five hours, the same

portion of water lost only 31°, being found at 84° though the temperature of the air had in the mean time fallen to 76°. On another occasion, the loss was 9° per hour, or from 212° to 104° in twelve hours, in an apartment where the air was at 60°.

The vessel above described charged with about 15lbs. of water, was suspended to one hook of the scale beam, while to the opposite was attached the usual pan for weights. The water was then brought to a state of rapid ebullition by heaters, previously plunged for an instant into another vessel of water, to take off any portion of ashes or oxide which might accidentally adhere to the surface. When assured that the water and its container had acquired the boiling temperature, I replaced the cover, and immediately adjusted the weights to an exact counterpoise. The piece of hot metal whose power of producing steam was to be ascertained, was upon removing the cover immediately plunged into the boiling water, and permitted to remain until ebullition ceased. At that instant, the metal was withdrawn, the time noted, the lid adjusted and weight added on the side of the boiler, to compensate for the evaporation of water, until the equilibrium was restored. The experiments were conducted with all due caution to avoid the waste of water, which might ensue from the violent agitation, caused by plunging the metal all at once below the surface. The metal was either lowered gradually into the water, or, when plunged in immediately, was suspended to a wire, attached above to a cover, perforated with numerous holes, to allow the escape of steam, and furnished with a broad funnel shaped rim to receive and return any water which might be projected through the apertures.

In order to avoid communicating to the apparatus a temperature above that of the liquid, the metal was suspended in the water, and not allowed to touch the sides or bottom of the cylinder.

The difficulty of ascertaining with precision the temperatures above the boiling point of mercury, (660°) compelled me to adopt as a standard of comparison, between the different metals, and between different masses of the same metal, a point indicated by the senses. A *barely red heat in daylight* was chosen, as least liable to be misapprehended. Many experiments have been made at temperatures both above and below this point; but as it is probable that the heated parts of boilers are seldom raised above a dull red heat, and that if they were so, their danger, or (perhaps we might say) their *safety*, would arise from the softness and yielding condition of the metal, it has been thought that for practical as well as theoretical purposes, the point above mentioned would be most interesting and

important. The experiments to determine the period of *greatest activity* will show, that just below the point of visible redness in daylight, the greatest quantity of steam is generated in a given number of instants. Such at least is the case when the experiment is performed under ordinary atmospheric pressure. This point therefore, I have termed in the tables the *comparable temperature.* Many of the experiments with wrought iron were performed upon a piece of rolled boiler *plate*, 25½ inches long, by 7½ broad, and $\frac{3}{16}$ of an inch thick, affording a surface (including both faces, and all the edges) of three hundred and ninety five square inches. This was reduced to a coil, for the greater convenience in managing the experiments, but sufficient space was left for the free admission of water to every part of the surface. The first series was intended to exhibit the *quantity* of steam generated without particular reference to the time. The latter however was immediately noted on each occasion, but is not to be taken as the *least* time, in which the mass of metal employed could impart its surplus heat to boiling water. It serves to show that no essential difference was discoverable in the amount of steam produced by metal of the same temperature, whether the latter were immersed all at once, or only covered by degrees with the water, and that, consequently the portion of overheated surface which remained above the water, did not impart to the steam which ascended, any appreciable quantity of its caloric, during the experiment.

FIRST SERIES,

With rolled iron, 395 square inches of surface—water at 212° Fah.; barometer, 29.9 inches; the time marked by a pendulum beating seconds; temperature of the apartment from 80° to 85°.

No. of experiment.	Weight of metal in ounces avoirdupois.	Time in seconds.	Weight of steam in ounces avoirdupois.	Decimal part of an ounce of steam from each ounce of metal.	No. of ounces of metal that produced each ounce of steam.	Observed heat of the metal in day light.
1	144.	40	10.75	.0746	13.395	Black heat.
2	144.25	90	16.	.1109	9.016	*Comparable* or dull red in day light.
3	144.25	90	16.	.1109	9.016	*Do.* do. do.
4	144.125	90	16.	.1110	9.008	*Do.* do. do.
5	144.125	90	16.	.1110	9.008	*Do.* do. do.
6	144.	70	16.5	.1145	8.727	Slight incr'se in redness, plung'd sooner
7	144.	150	19.75	.1371	7.291	Clear red, immersed by degrees.
8	144.25	120	20.	.1386	7.2125	Bright red.
9	144.	90	21.	.1458	6.857	Brighter red.
10	144.	90	22.5	.1562	6.400	Very bright; metal yielding easily.

The 2d, 3d, 4th and 5th experiments, present a remarkable coincidence of results, and prove that at the temperature of comparison, nine pounds of wrought iron will generate one pound of steam, under atmospheric pressure. Subsequent series will show, that, but for the caution necessary to avoid waste, this effect might have been produced in twenty-five or thirty seconds, instead of the times above noted.

SECOND SERIES,

With wrought iron cylinders, 6 inches long, and 1.7 inches in diameter; surface, 38 square inches, including that of the hook; water kept at 212°.

No. of experiment.	Ounces avoirdupois of metal.	Time in seconds.	Ounces of steam produced.	Decimal part of an ounce of steam to one ounce of metal.	Ounces of metal for each ounce of steam.	HEAT OBSERVED.	REMARKS.
1	62.5	42	4	.0640	15.625	Black.	Iron immersed at once.
2	62.5	45	4	.0640	15.625	Black.	Do. do.
3	62.5	45	5.25	.0840	11.904	Black.	Do. do.
4	62.5	48	5.5	.0880	11.363	Black.	Do. do.
5	63	120	7	.1111	9.000	Dull red; comparative temp.	Do. by degrees.
6	63	120	7	.1111	9.000	Dull red; comparative temp.	Do. do.
7	63	120	7	.1111	9.000	Dull red; comparative temp.	Do. do.
8	63	120	7	.1111	9.000	Dull red; comparative temp.	Do. do.
9	63	80	7.25	.1150	8.689	Dull red; comparative temp.	Do. quickly but not *at once.*
10	62.5	90	7.75	.1240	8.064	Fair red.	Do. do.
11	63	150	8	.1270	7.875	Fair red.	Do. by degrees.
12	63	150	8	.1270	7.875	Fair red.	Do. do.
13	62.25	100	9.5	.1365	6.552	Full red.	Do. at once.
14	62.25	120	10.5	.1686	5.928	Bright red.	Do. do.

The striking correspondence in the results of those experiments in the above series, which purport to have been made at the *comparable temperature* (No.'s 5, 6, 7, 8 and 9) with the analogous ones in the *first series*, render it evident that in this form, as well as in that of the plate, the amount of steam generated by any portion of wrought iron at a dull red heat, bears a direct relation to the weight of metal, being one pound of steam to every nine pounds of iron.

THIRD SERIES,

With cylinders of cast iron of different weights, and at different temperatures; water at 212°. The surface exposed in each experiment, is indicated in a separate column.

No. of experiment.	Weight of metal employed, in ounces.	Time in seconds.	Ounces of steam produced.	Dec. part of an oz. of steam to 1 oz. metal.	Ounces of metal to 1 of steam.	Square inches of surface.	HEAT OBSERVED.	REMARKS.
1	60	30	2.25	.0375	26.666	37.69	Black.	Immersed at once.
2	168	60	6.75	.0401	24.888	86.25	Do.	Do. do.
3	152	80	7	.0460	21.714	77.47	Do.	Do. by degrees.
4	60	50	3.375	.0562	16.000	37.69	Do.	Do. at once.
5	168	90	14.25	.0848	11.789	86.25	Do.	Do. do.
6	152	135	13.75	.0904	11.054	77.47	Do.	Do. do.
7	60	55	5.5	.0916	10.909	37.69	Do.	Do. do.
8	60	55	5.5	.0916	10.909	37.69	Do.	Do. do.
9	168	105	15.5	.0922	10.838	86.25	Do.	Do. do.
10	168	106	16	.0952	10.500	86.25	Do.	Do. do.
11	60	60	6.5	.1083	9.230	37.69	Low red in the dark.	Do. do.
12	60	55	6.75	.1125	8.888	37.69	Do.	Do. do.
13	60	55	6.75	.1125	8.888	37.69	Do.	Do. do.
14	61	90	7	.1147	8.714	37.69	*Comparable*, (dull red in day light.)	Do. by degrees.
15	168	300	19.5	.1160	8.618	86.25	Do.	Do. do.
16	168	300	19.5	.1160	8.618	86.25	Do.	Do. do.
17	61	105	7.25	.1185	8.413	37.69	Do.	Do. do.
18	61	105	7.5	.1229	8.133	37.69	Do.	Do. do.
19	61	120	7.5	.1229	8.133	37.69	Do.	Do. slowly.
20	152	300	19	.1250	8.000	77.47	Do.	Do. do.
21	152	300	19	.1250	8.000	77.47	Do.	Do. do.
22	152	300	19	.1250	8.000	77.47	Do.	Do. do.
23	60	70	7.75	.1291	7.741	37.69	Brighter red.	Do. almost instantly.
24	152	300	21	.1316	7.238	77.47	Clear red.	Do. gradually.
25	61	90	8	.1331	7.625	37.69	Do.	Do. in few seconds.
26	61	120	8.5	.1393	7.176	37.69	Do.	Do. gradually.
27	168	180	23.5	.1398	7.149	86.25	Full red.	Do. do.
28	60	75	8.5	.1416	7.058	37.69	Do.	Do. at once.
29	151	300	22	.1457	6.864	77.47	Do.	Do. gradually.
30	61	120	9	.1475	6.727	37.69	Bright red.	Do. do.
31	152	180	29	.1908	5.241	77.47	Do.	Do. in few seconds.
32	60	105	11.5	.1916	5.217	37.69	Very bright.	Do. rapidly.
33	152	270	32.75	.2154	4.641	77.47	Do.	Do. gradually.
34	152	360	34	.2237	4.470	77.47	Do.	Do. slowly.

It appears from the preceding table, that the least amount of steam given by any of the experiments, was that of No. 1. where, under the head of *decimal parts*, we find $3\frac{3}{4}$ per cent.; and the greatest amount was that of No. 34, where the same column exhibits $22\frac{37}{100}$ per cent. In the latter case, $4\frac{47}{100}$ lbs. of metal gave a pound of steam, while in the former, $26\frac{2}{3}$ lbs. were required for that purpose.

A comparison of the third series with the two preceding, will show that at the *comparable temperature*, cast iron is capable of generating more steam for each unit of weight in the metal, than wrought iron. It may possibly be found that the temperature of *luminousness* in the two kinds, is different. But from heating similar masses of the two, side by side, in the same exposure, and observing no difference in the time of coming to redness, I have been led to attribute the difference to a difference in the specific caloric of cast and wrought iron; a circumstance which would probably be sufficiently accounted for, by the difference in their constituent elements.

The mean amount of cast iron to each pound of steam in the nine experiments marked *comparable*, is $8\frac{381}{1000}$ lbs. We might probably assume $8\frac{1}{4}$ as the number, without material error.

A great many experiments, tending to show the period of most rapid action of hot metal upon water have been performed, but the limits of the present paper require that the results of these, as well as the account of experiments on copper, brass, silver and gold, should be postponed to a future number.

Art. VIII.—*List of the Plants of Chile; translated from the "Mercurio Chileno," by* W. S. W. Ruschenberger, M.D. U. S. Navy.

(Continued from page 70.)

Ammi Visnaga. Lamark. Vulgarly *Visnaga;* very common in fields. It is a poor plant, of which no use is made, except that tooth-picks are formed of its dried peduncles. It is not eaten by animals and it would be useful to find the means of extirpating it entirely.

Amygdalus communis. Linn. Almond. A cultivated tree, which it would be proper to multiply. On account of its qualities, and the different uses to which the almond may be applied, its extensive cultivation would, in a commercial view, be advantageous to the country. Its wood serves for the finest kinds of joiners' work. The oil of almonds, so useful in medicine, is, when found at all, always very expensive in this country. The variety with a soft shell is to be preferred, on account of the facility with which it is broken. The *Amygdalus Persica*, Linn. is among the most common fruit trees. A great number of varieties, early and late, are enumerated, both with naked

and downy fruit, *free* and *cling stones.** And hence the names *duràzno prisco*, priscan peach; *duràzno de la Candelaria, de invierno, &c.* peach of Candelaria, winter peach, &c. The fruit is generally good, sometimes excellent, although it is rare. It would be much better to perfect it by grafting.† A syrup is made of its flowers, called *xarave de duràzno*, peach syrup,‡ which is given as a purgative.

Amyris. The tree called *Molle* belongs to this genus and not at all to the *Schinus*, whose leaves are compound. Its trunk is from eight to ten varas high. The wood is hard in the center and is employed in making cart hubs and forks for ranchos.§ The part which is set in the ground, puts forth roots and thus adds to the solidity of the edifice. The essential oil and the resin yielded by the tree are employed as remedies in spasmodic affections. The decoction of the bark is extolled in nervous diseases.

Anemone. Two species are known. The first is cultivated and is the *A. coronaria*, Linn. a variety with double flowers, *Arèmula* of the gardens, a pretty plant, which should be multiplied on account of the singular and varied shades presented by its flowers. The second is indigenous, and is the *A. Helleborifolia*, DeCandolle called in the country *Centella.* I think it is only a variety of the *A. decapetala*, Linn. because I have had occasion to remark the different relations of one species to the other. This plant is caustic. Its leaves applied to the skin produce the effects of a vesicatory. If sown in gardens, with the necessary precautions, a variety with double flowers would be easily obtained, which would be appreciated for having its petals white on one side and blue on the other.

Anthemis arvensis. Linn. *Manzanilla bastarda*, bastard chamomile, common in the fields and meadows. Its penetrating odor insures it a place among the *nervines*, but it is more disagreeable than the *Matricaria Chamomilla*, Linn. *Manzanilla de Castilla*, Spanish chamomile, and for that reason it is seldom employed.

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* "Con hueso libre, y adherente à la carne."

† The peaches of Chile, though very fine in appearance, will not bear a comparison with ours in flavor.—T.

‡ Peach jam?

§ The rancho is a rude hut, commonly formed by planting four poles, five or six feet in length, with forked extremities, on which cross pieces rest and are lashed with raw hide, for the purpose of supporting the roof of thatch. The walls are made of the same material. The smoke finds its way out through the door way or window holes, which in cold weather are closed by raw hide, sometimes stretched over square frames made to fit the apertures.—T.

Anthericum cœruleum. Ruiz and Pavon. *Pajarito azul*, a very common plant in woods, but perhaps, on a comparative examination, it would be separated from this genus. Its flowers are of a magnificent blue. It deserves to be cultivated.

Antheroceras. A new genus, which bears great resemblance to the *Sowerbæa*, Smith, originally from New Holland. There are two species; the *A. Ornithogaloides*, (Guilli,) and the *A. Oderum*, Bertero, (Guilli de San Francisco.) They grow in sterile and stony pastures; the first on the mountains, the second in the plains. Both merit cultivation.

Anthoceros punctatus. Linn. is found in pastures and humid ravines.

Antirrhinum majus. Linn. An European species, cultivated in gardens, for the singularity of its corolla, which varies from white to red; its form has given it the vulgar name *cartuchos*, cartouches.

Apium. Two species, coming from Europe; the *A. graveolens*, celery, and the *A. Petroselinum*, Linn. parsley. Both are cultivated in olitories and are applied to the same uses. A decoction of the root of parsley is prescribed in cases of retention (suppression?) of urine.

Aquilegia vulgaris, Linn. and its varieties are cultivated in gardens, under the name of *Campanilla.*

Arachis hypogæa, Linn. vulgarly *many*, rather rare in gardens. It should be extensively cultivated for the oil, which may be obtained from the seeds, and to make the expensive sweetmeats which are brought from Lima.

Arenaria. I have met with many species of this genus. The *A. media*, Linn. and its variety, *marina;* the *A. Cerviana*, Chamiss, and two species probably new.

Argemone Mexicana. Linn. Called *cardo blanco*, white artichoke; quite common near roads and torrents. There is a variety with white flowers three times as large, which in my opinion is the *A. albiflora*, Horn. and which should be made a distinct species. Its bruised seeds applied to aching and decayed teeth relieve the pain. Its affinity to the *Papaver* insures its success.

Aristotelea Macqui. Herit. Vulgarly *Macqui*, a kind of ginger, very common near torrents and in shady woods. Its leaves, when chewed, cleanse ulcers of the mouth. Powdered and in decoction, it is applied to every kind of sore. Its wood is smooth and is used to make musical instruments. Its bark supplies strings. Children

and people in the country eat the fruit, which is violet or sometimes white. With its juice ices are made, and mixed with the grape it yields an agreeable though a rough wine. The *Cornus Chilensis*, Molina, is the synonym of the tree of which we are speaking, and Steudel is mistaken when he cites both names in his *Nomenclator botanicus.*

Armeniaca vulgaris. Lamark. A tree from Europe, where it is cultivated. Many varieties more or less esteemed, are recognized. The *Damasco* is one of them, and the *Albaricoque*, the apricot, another, which in Europe is delicous, where, from the process of grafting, it acquires an exquisite flavor.*

Armeria curvifolia. Bertero. A native plant of this country, and very common in stony places, about the hills, and near rivers. Although it very much resembles the *A. fasciculata*, it is distinguished from it by its leaves. The whole plant is very thick, and its flowers, sometimes white, but more commonly rose color, obtain for it a distinguished place in gardens.

Artemisia Absinthium. Linn. *Ajenjo*, a plant whose medicinal virtues are well known. It is cultivated in gardens, and is employed as a tonic and vermifuge.

Arundo. The *caña de Castilla*, Spanish cane—*A. Donax.* Linn: it is commonly cultivated. The decoction of its root is considered a pectoral, as is also its syrup. Both are employed in affections of the chest. The *coliu* or *coligue* is a species of *Arundo*, described by Molina. Sprengel in his *Species Plantarum*, does not mention it. Not having seen the flower, I can say nothing on this point. It is one of the most useful plants of this country. It serves for different purposes, and particularly to make the *matting* (esteras,) with which houses are covered before the roof is made.† The *A. dioeca*, Sprengel, is quite common on the margins of rivulets. In some places it is called *cola de zorro*, fox-tail—and in others *cortadera.*‡ The decoction of its roots is prescribed in urinary affections.

Asparagus officinalis. Linn. This plant, although brought from Europe, may be considered as naturalized to this country, as it is frequently found in uncultivated places. It is called *espárrago*, aspar-

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* It is a remarkable fact, that almost all the fruits of Chile, which have been introduced, possess very little flavor.—T.

† All the houses in Chile have tile roofs.

‡ A chisel for cutting hot iron.

agus, and is eaten dressed as in Europe, but I have never seen it attain half the size to which it might be brought by a little care in the cultivation.

Aspidium, a species resembling the *A. rhæticum.* Linn.: called *Helecho*, fern. It grows in the shady woods of the hills. The decoction of its roots is a vermifuge.

Asplenium ciliatum. Presl. Common ravines and elevated situations. It is confounded with the *Adiantum*, under the name of *Culantrillo*, maiden-hair.

Astragalus. The name *yerba loca*, wild grass, is given to a species of this genus which grows near rivers, and in sandy pastures of the plains, very hurtful to cattle and particularly to horses. It is the *A. unifultus.* Herit. I think I have met with the *A. garbanzillo*, Cavanilles, under the same denomination. A third which appears new, and has the veins triangular, is common in the arid spots of Leona, and on the banks of the river Cachapual.

Avena sativa. Linn. It is met with every where: it is not cultivated, nor is it of the least use in this country, while in Europe, it yields its grain for horses, and nourishes and fattens them.

Azara dentata and *A. serrata.* Ruiz and Pavon. These two shrubs are known under the name of *Corcolen.* They are common in the woods, both of the plain and of the hills. The last has downy leaves, and appears to form a different species. Its appearance is elegant, and its numerous flowers make it a valuable addition to the embellishments of a garden. The *Lilen*, belongs to this genus: I have called it *Azara Lilen*, and I even think that it might form a genus which I would call *Lilenia*, which I will do when I have examined the fruit in a state of perfection.

Azolla Magellanica. Willdenow. Common in stagnant waters, upon which it forms a magnificent thrifty growth. It is one of the plants known under the name of *Cuchicillo.*

Baccharis. Linn. Many species of this genus are common in the plains and on the hills, some herbaceous and others fruticose. The name of *Chilca* is given to the *B. glutinosa*, Pers. to the *B. Alaternoides*, Humb. Bonpl. and Kunth, and to the *B. Banksiæfolia*, Bertero. The *B. linearis*, Pers. is called *Chilquilla*, a name common to other herbaceous species resembling the *B. linearis.* The *B. Montevidensis*, Spr. and the *B. Chilco*, Kunth, are known by the name of *Romero de la tierra*, *Romerillo.* It should be observed, that the *Rosmarinus Chilensis*, Molina, cited by authors, and

lately by Sprengel, has no existence, and ought absolutely to be blotted from botanical catalogues. The branches of this plant are commonly used to heat lime kilns, and to light fires on holy-days; the resinous principle which it contains causes rapid combustion. Brushes are also made of it, which however, do not last long. The *B. glutinosa* yields, by boiling, a kind of resin, which, it is said, has various applications. The decoction of this plant is used as a refrigerant in certain urinary affections.

Barbula. Hedw. Among the mosses which grow in this country there are some which belong to this genus. The most common resembles very much the *B. unguiculata*, Hedw. The *B. muralis*, Timm. is not rare. All the mosses are generally known by the name of *pastito*. They grow in shady and humid spots in the woods; at the foot of old trees, near bogs, and on mud walls. They are not applied to any particular use.

Bartramia. Hedw. There are two species: the one resembles the *B. fontana*, Sw. The other appears new. They are found in the shady woods of the hills, and in the sandy and humid pastures near rivers.

Berberis Ilicifolia. Forst. and *B. tomentosa*, Ruiz and Pavon. These two under-shrubs, which are called, indiscriminately, *Michay*, are very frequent in arid and elevated hills. The last is common in the neighborhood of Leona. It would be well to attempt its cultivation, to form inclosures which would be impassable on account of the strong sharp thorns on its leaves.* The decoction of its bark forms

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* The construction and preservation of the mud walls, which serve for the separation of property, and to prevent the invasion of animals of the herd, cause very considerable expense, but are nevertheless of prime necessity. The long rains of winter and strong winds and earthquakes produce great damage, which it is necessary to repair without loss of time, with sacrifices that circumstances render onerous. Besides, the sad aspect of these walls, which cross in every direction a fertile plain, destroys, in a great measure, the beauty of the country, and conceals the beautiful green, enamelled with the most splendid colors of the Iris, with which nature is every where adorned. The roads, shut in by these rough constructions, are dull, monotonous, tedious, and above all, impassable on account of the waters, which can find no exit. Would it not be less expensive and more convenient to replace them by *living palings*, which being well guarded and separated from the public roads by ditches, would form secure and, at the same time, cheerful barriers? Although the country does not want for thorny shrubs, susceptible of this application, yet it would be well to introduce the cultivation of the *Cratægus Oxyacantha*, Linn. and its varieties, known in Spanish under the name of *espino blanco*.—B.

a bright yellow dye which would be useful, if means were found to fix it.

Beta vulgaris. Linn. *var.* Vulgarly, *Beterava*—beet root? cultivated and employed as an article of diet. Some are very sweet; but in general they are of a middle size. By a careful cultivation, very large roots would be procured. It is strange that the plant known in France by the term *bette*, and in Spain by that of *Acelga*, is scarcely found in the olitories of this country. It is one of the garden stuffs, which, like spinage and sorrel, should be cultivated, since it increases the resources of the kitchen, and would advantageously supplant the *yuca* and *blédo*.

Bidens. Linn. Three indigenous species, the *B. Helianthoides*, Kunth., which grows in ditches and in the marches, near Aculeo and Angostura; the *B. Sambucifolia*, Cav., which is met with in gardens and cultivated places, and another which appears to me new, and which I have collected on the arid heights near Taguatagua.

Blandovia striata. W. A very small plant of the hepatic family, quite common on the margins of marshes, near drains, and on walls in damp and shady situations.

Blechnum hastatum. Kaulf. A Fern called in this country *Palmilla.* It grows in the woods at the foot of trees, near ditches on the hills and plains; it is a pretty plant, but applied to no use. Its root should be tried in verminous affections.

Boerhaavia glutinosa. Miers. Common in stony places, and on the arid hills near roads. It resembles very much the *B. hirsuta*, Linn., and perhaps is only a variety of it.

Bolax. Commers. The *B. caespitosus* and the *B. spinosus*, Spr. grow upon the hills and near Cachapual, in stony and sandy situations. It is of no use.

Boletus. Linn. To the species, the names of which have already been published, must be added *B. Molluscus*, Pers. common in rotten wood; *B. fomentarius*, and *B. ignarius*, Linn. to which the name *oreja de palo* has been given. These last grow on apple and pear trees, and form yeast with very little preparation.

Borrago. Linn. A plant cultivated in gardens; it is called *Borraja*, and appears to differ in the leaves from the *B. officinalis*, Linn. When tender, it is edible. It is daily employed to make refreshing and diuretic ptisans.

Botrytis glauca. Spr. A moss or mould found on preserved substances when beginning to rot.

Bovista. Pers. There are three species of this genus; one grows on the sides and tops of hills. It very much resembles the *Lycoperdon molle*, Pers.; the second, the *B. plumbea*, Pers.; the third, and most common of all, acquires a considerable size, and may be associated with the *B. nigrescens*, Pers., or with the *B. gigantea*, Nees. It is frequently found in the *prados* of the plains. They are all known under the name of *Polvillo del Diable*—Devil's dust. The abundant powder which comes from these plants is employed, by some, to arrest hæmorrhages arising from wounds.

Bowlesia. Ruiz and Pavon. I am acquainted with three species of which, two, in my opinion, are new. The *B. Geraniifolia*, Schlecht. is common in inclosures, on the banks of drains, and in inhabited situations; the other two grow on elevated hills. One is found in sterile and light places, the other in woods and shady situations. They have no vulgar names, and offer nothing remarkable.

Brassica. Linn. Plants whose cultivation should become more extensive and improved on account of the domestic resources which they offer. The *B. oleracea*, Linn. (cabbage,) and its numerous varieties, as the cauliflower, the broccoli, the *B. Rapa*, of great use in Europe, and the *B. Napus*, Linn. (rape seed.) All these species, and in preference their different varieties, should fix the attention of horticulturists, because they minister new enjoyments, and pecuniary advantages. The plains, and even more, wheat fields are infested by the *B. campestris*, and by the *Raphanus sativus*, Linn. The leaves of the first are eaten, cooked like spinage. It would be better to destroy them, and only to cultivate that variety of the first, known in France by the name of *Cobzat*, the seeds of which yield an oil which is applied to many purposes, an object of primary importance in this country. Among the species of this very interesting family, there are many which should be introduced, as they would prosper, and would be of great use, such are the *Eruca sativa*, Lamk. (Roquette des jardins,) the *Diplotaxis tenuifolia*, De Cand. the *Lepidium sativum*, Linn.; the *Cochlearia officinalis*, Linn. an eminently antiscorbutic plant; others, finally, would serve to adorn gardens, as the *Hesperis matronalis*, and its varieties, the *Lunaria biennis*, Moench, L. *rediviva*, Linn.

Bromelia. Linn. I have met with three species of this genus, one of which is designated by the names *Chagnal*, *Magney*, *Cardon* or *Puya*. At present it makes a part of the genus *Pourretia*. Ruiz and Pavon. The other two are the *B. sphacelata* and *B. bicolor*.

Ruiz and Pavon. They are found in arid and craggy situations about mountains, in ravines and on the edges of precipices. The first is also called *Cardon*, and the second *Cardoncillo*. These plants may be employed in hedges, particularly on the heights, where others will not grow. By this means lasting lines would be traced that would serve as boundaries to property, without the necessity of carrying stone or timber, the transportation of which is expensive and difficult.

Bromus pratensis and *B. mollis*. Linn. Plants from Europe: frequent in fields, plains and vineyards. The first is usually called *cebadilla*, little-barley.

Buddleia globosa Linn. Vulgarly *pañil*, a small tree, which grows near rivers, and is sometimes cultivated near houses. The leaves and their decoction are employed in medicine. I have seen a variety cultivated, which differs in nothing from the *B. glabrata*, Spr., lately discovered in Montevideo. These two trees should occupy a distinguished place in landscape gardens.

Cactus. Linn. Some species are proper to this country. The *C. Peruvianus*, Linn., is very common on the heights, in the mountains, and in arid places, and on the plains near rivers. It is called *Quisco*. There is another very small species in the stony places of Leona, which resembles the *C. Coquimbanus*, Mollina, but might, perhaps, form a different species. The third, common in the ravines of hills, and in the stony situations on the banks of Cachapual, approaches to the *C. recurvus*, Mill. I have called it *C. curvispinus*. In some gardens the *C. Coccinillifer*, Linn., is cultivated, to which the name *tuna* is given. Its fruit, called *guiyaves*, a name which is generally given to others, is edible. This last is the same which serves for aliment to the cochineal. Its cultivation might be attempted in the plains of Coquimbo, where the temperature is favorable to it. The parenchyma of these plants, very succulent and mucilaginous, might replace those commonly employed in medicine for cataplasms and emollient decoctions, particularly in winter, and in the country, where from idleness the future is seldom thought of.

Cæsalpinia. Linn. A beautiful tree, admired for its flowers. It is said to come from Mendoza. It is cultivated in some gardens by the name of *Barbon*. It resembles much the *Pomaria glandulosa*, Cav.; a genus united to the *Cæsalpinia* by some botanists of our day. Nevertheless, I think it differs from it, and ought to be called *C. Barbon*.

Calceolaria. Linn. The species of this beautiful genus are sufficiently numerous, and very common in this country. They inhabit the mountains, the hills and the plains. They are fruticose and herbaceous. Almost all have the corolla yellow; I have seen but one with yellow flowers. Many of them are denominated *arganita.* The following may be cited as the most notable:—*C. alba, bicrenata,* Ruiz and Pavon, *integrifolia,* Bot. Reg., *montana,* Cav., *rugosa, sessilis,* Ruiz and Pavon, *Verbascifolia,* Bertero, and many others, which are difficult to determine. Among the last, the most interesting is the *Palpi,* which is employed to make a yellow dye, sufficiently durable. Its cultivation in gardens would have a fine effect, from the different aspects of its flowers, which are very numerous, and variously disposed.

Calendula officinalis. Linn. Vulgarly *China,* cultivated in gardens. Some esteemed varieties are met with, particularly with double flowers.

Calliopsis tinctoria. Reichenb. A valuable plant, recently introduced, and which should be propagated for the elegant color of its flowers.

Callitriche autumnalis. Linn. Common in drains and clear waters. I have met with a distinct variety, which grows in shady and humid situations in gardens. I think it has sufficient characteristics to separate it, and give it the name of *C. Turfosa.*

Campanula Chilensis. Mollina. It is found in the arid and stony situations about the hills which surround Valparaiso. The *C. Medium,* Linn., called *Faroles,* from the figure of its corolla, is cultivated in gardens.

Canna Indica. Linn. *Achira,* frequent in gardens, where it serves as an ornament from the beautiful green of its leaves, and the color of its flowers, which have a peculiar form.

Capsella Bursa Pastoris. D. C. Very common every where, and particularly in olitories, where it sometimes becomes dangerous. It is a plant of Europe.

Capsicum annuum. Linn. (*Aji dulce, pimiento de Castilla,*) and *C. frutescens.* Linn. (*aji pimiento de las Indias.*) A multitude of varieties of this plant is cultivated, to which different names are given. The fruit is much used in this kingdom, and particularly in the country. The most piquant are the most esteemed, and are the object of considerable commerce. The inhabitants are accustomed from their infancy to strong tastes, which is the fact through all South

America. Although the climate, and particularly habit and circumstances sanction their use, the rules of moderation should nevertheless, not be forgotten. Very irritating substances, used in excess, vividly attack the digestive powers, and destroy them by increasing their action. Hence the origin of many diseases common in Chile, which are more or less troublesome, and in certain cases become even dangerous, as dyspepsia, acidity, pains of the stomach, flatulence, and sometimes Gastritis. It is proper to diminish, and even to prohibit the use of these aliments (condiments?) by youth, and by irritable and delicate temperaments, and above all, to overcome the contempt with which the principles of Hygiene are too generally looked upon.

Cardamine. Linn. Four species are proper to this country. The *C. Chilensis.* D. C. Common in the humid pastures of the hills; the *C tuberosa*, &c. in stony situations on the mountains, the *C. flaccida*, Chamiss. in sandy places, and the fields of the plains, near rivers, and the *C. Nasturtioides*, Bertero, abundant in the marshes near the torrents of Taguatagua and Rio Claro. The last resembles the *berro*,* and is confounded with it.

Cassia. Linn. A small shrub, is met with in some gardens, which is called *sen*, and which I believe to be the *C. Crotalarioides*, Kunth., or a proximate species. The leaves are employed in powder, and in decoction, as a purgative. There is another frutescent species, which grows in the ditches and woods on the Valparaiso road, which I shall call *C. flexuosa.* It merits cultivation for the beauty of its leaves, and for the large size of its flowers, which are of a strong bright yellow.

Castanea vesca. Gærtn. Chestnut. A large tree introduced into Chile a long time ago, and though very useful, is not esteemed as much as it merits. Its fruit (chestnuts,) serve as an aliment; the wood is used in carpentry and for heavy works; its coal is preferred by blacksmiths, and lastly, whole countries in Europe are sustained by the product of this tree. It should be cultivated in preference, in valleys and the recesses found at the foot of mountains.

Celosia cristata. Linn. Cultivated in gardens under the name of *Penacho.* It varies much as to its form. Though common, it may serve as an ornament to gardens by the monstrosities and strange figures it assumes.

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* Water-cresses.

Centaurea Americana. Spr. A weed, common in fields and vineyards, called *zizoña.* It may be employed to make bitter ptisans. It is more active than the *C. solstitialis*, Linn. of Europe which it resembles. The *C. Chilensis*, Miers, one of the most beautiful of this genus, is frequent on the hills and on the banks of the Cachapual, near Cauquenes. It is called *escabiosa*, and *yerba del minero.* The beauty of its flower recommends it for prospect woods, (bosques de adorno.) The bitterness of its leaves announces that it may be employed in medicine with happy effects. In fact, it is prescribed both internally and externally in many diseases, and marvelous stories are told of its powers.

Cerastium vulgatum. Linn. It is found in fields and meadows. There is also the *C. Commersonianum.* Ser. (in D. C. prodr.) Common in the humid pastures of the hills, and a third species which grows among stones, and in dry and sandy situations of the mountains and plains. I think it is new.

Cerasus. Juss. Vulgarly *guindo*, *cereso*, cherry. A cultivated tree, the fruit of which is not prized in Chile. In fact, it is little eaten, and is employed only in making sweetmeats. The cherries of Europe have an exquisite and much esteemed taste. Should such a difference be attributed to the climate? Proprietors should seek good grafts, take care of their trees, and in that way solve the question in favor of the country. The mildness of the climate and the fertility of the soil, are not sufficient to secure that perfection which is attained in Europe, where a knowledge of the principles of horticulture is so widely diffused.

Cestrum Parqui. Herit. A small shrub, common in meadows, near inclosures, and the drains on the plain. The leaves of the *Parqui*, their infusion and the decoction of the root, are employed in almost all diseases. This plant and the *Culen* are universal remedies in the country.

Chabræa abbreviata, *elongata*, *Prenanthoides*, *tenuior* and *viscida.* Bertero.* These plants grow in meadows, woods, and in stony

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* The tribe of the *Perdicieæ* merits the attention of botanists. A good monograph is indispensable on account of the great number of species lately discovered. Chile produces many which appear new to me, and some of which might constitute new genera. The five species of *Chabræa* above named offer an example, as well as the shrub vulgarly called *guanil*, which participates with the *Proustia*, Lag. and with the *Baccazja*, Ruiz and Pavon: but differs from them essentially. There are two species, one of them less frequent, with leaves downy, and whitish underneath. I possess other plants of this tribe, but I think it useless to speak of them at present.

situations on the hills and plains. Almost all merit introduction to the garden for the beauty of their flowers, which, at first sight, are mistaken for those of the *Senecio elegans*, Linn. a species which should be obtained, and particularly its variety, with double flowers.

Chætanthera Chilensis. D. C. *ciliata.* R. and Pav. and two others, the description of which I have not seen. They grow in the dry pastures of the plain, and in arid sites on the mountain. They are so common in some places that their flowers form a carpet, which is quite agreeable to the eye, and may be seen from a great distance.

Chætomium globosum. Kunz. A small fungus which is found on the dead and rotten shoots of plants in gardens during the winter.

Chara clavata. Bertero. In marshes and in some stagnant waters. It bears some resemblance to the *C. vulgaris*, Linn. but differs from it by constant and well defined characteristics.

Cheiranthus incanus, and *C. Cheiri.* Linn. Cultivated in gardens, and known by the names of *aleli blanco*, *colorado* and *caña.* The varieties with double flowers are not so frequent as they should be, and might be easily obtained by different means of propagation, which should be known to gardeners and amateurs.

To be Continued.

Art. IX.—*Notice of the Mine of Spathic Iron (Steel ore) of New Milford, and of the Iron Works of Salisbury, in the state of Connecticut;* by Charles U. Shepard, Assistant to the Professor of Chemistry, Mineralogy, &c., and Lecturer on Botany, in Yale College.

Mine of Spathic Iron in New Milford.

About the middle of the last century, as is well known, the land in most of the hilly towns in the western part of Connecticut, belonged to small companies of settlers, who divided it out into extensive tracts among themselves, or to others, at prices regulated by its supposed value for agricultural purposes. This was the case with the town of New Milford, in Litchfield county. Traces of ore being accidentally discovered on a mountain situated upon Shepaug river, hopes were immediately entertained that a silver mine would be discovered in that neighborhood. Accordingly, one of the company, by the name of Hurlburt, purchased the entire mountain; which ex-

tends for upwards of a mile in a north and south direction upon the river, and back for about the same distance. Hurlburt commenced digging at a spot within fifty rods of the summit of the mountain, and at a distance of nearly half a mile from the river. He was assisted in the undertaking by some of his neighbors; one of whom, by the name of Hawley, became a joint partner with him in the enterprise. Their only object was silver; but whether they believed the Sparry Iron to afford this metal, or supposed it to exist in the occasional admixtures with it of other ores, is not now known. Neither is it certain, to how great depth they followed the vein; but it may be presumed that their limited resources, added to the embarrassments then existing in the scarcity of proper instruments and the dearness of gunpowder, must have prevented their penetrating the ore to any considerable depth. After a few years of fruitless search for silver, they abandoned the undertaking, and sold out their right in the mountain to the Brunsons, (brothers.) These men, struck with the richness and extent of the vein, which had already been uncovered in numerous places, and imagining, no doubt, that ignorance and limited resources had been the sole causes of the ill success which had attended the opening of the mine, resolved upon the organization of a company to carry forward the work in a more energetic and scientific manner. Accordingly, the mine was divided into sixteen shares; which sold readily for £100 the share,—a sum, which, if we take into consideration the value of money at that period, clearly evinces the high expectations of profit which were then formed of this mine. Many of these shares were divided and sub-divided, and sold out in halves, fourths and eighths. The object of search with the company was the same with that of their predecessors. They procured as their agent, a German, by the name of Feuchter. This man was a goldsmith by trade; and his ignorance of ores and of the whole business of mining was equalled only by the credulity of his employers. The working commenced with great spirit, and following the shaft at *a*, (see map on opposite page,) they began to throw out an abundance of the Sparry Iron. A building was erected, near by, for the accommodation of the workmen; and a furnace for the reduction of the ore. As the German carried on all his processes of reduction and refining in secret, we have no certain knowledge as to the kind of ore which he used; but from the small value attached to the Sparry Iron until a period long subsequent, and the contracted dimensions of the furnace used, it seems most

reasonable to suppose, that it was the Blende, or Sulphuret of Zinc, which he attempted to reduce. He is said to have produced from time to time, small quantities of silver, to keep alive, no doubt, the hopes of his employers. Thus the enterprise went forward for many years. The depth of their excavation is not certainly known at present; but from existing reports, and the fact that they found it ne-

cessary to sink a lateral shaft for ventilation, it is imagined they must have penetrated to a depth, at least, as great as one hundred and fifty feet. At last, the owners, finding the prospect of adequate returns from the mine constantly diminishing, became discouraged; and the works were a second time abandoned.

The result of this experiment, it would seem, might have put the working of this mine, for silver, forever at rest; but a circumstance

which occurred relating to the departure of Feuchter, appears to have been in part, the cause, of exciting fresh delusions. When the German left the place, he was assisted by several persons in the removal of a number of very heavy boxes. One of these, accidentally falling to the ground, burst open; and revealed to the eyes of a negro slave a quantity of bars and ingots, which he afterwards described as having the color and look of pewter. The agent was now suspected to have carried on the working of the mine fraudulently, and to have caused its products to be surreptitiously conveyed out of the country for his private advantage; and we find the mine again gaining character as a valuable deposit of silver. The resources of the neighborhood, however, appear to have been too much weakened for a third experiment; and accordingly a company was organized in the city of New York, who came forward and obtained a lease of the mine for the term of forty three years. They commenced operations upon a much wider scale than either of the former companies; and they have left behind the evidences of a very heavy expenditure. Their works exhibit more science in the working of mines; but their ignorance and delusion respecting the nature and value of the ores must have been not at all inferior to that of their predecessors. According to the best information to be had at present, they commenced by continuing the shaft at *a*; but the water coming in, in great abundance, they were obliged to betake themselves to the plan of a horizontal adit or gallery, in order to accomplish its drainage. They accordingly descended the mountain towards the river in the direction of the vein, removing at intervals the accumulations of soil and loose rocks which conceal it throughout its whole distance. Thus, they revealed the vein at *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, and *k*,: and, from an inspection of the greater part of these places, it is impossible to conceive why, if the Sparry Iron was the object of their search, they had not contented themselves by working the vein, *sub die*, at a point as near the river as possible; since at many of the above mentioned points, it is obvious, that this ore is as abundant, and the vein as wide, as at the first made opening. They, however, decided to commence their gallery at *h*, and to continue it through the vein, until they should strike the perpendicular shaft at *a*, distant about half a mile. Had their sole object been to drain the shaft *a*, this object might have been effected by an adit from the point *o* with a saving of at least two thirds the distance, although the labor of following the vein, it must be confessed, is considerably less than that of penetrating the

main rock of the mountain. They are said to have carried in their gallery for twenty rods, with a height of four or four and a half feet, and the full width of the vein, which does not vary much from six feet. The mouth is at present blocked up by the falling in of rubbish; but the accumulations of ore brought out renders this account highly probable. The result of this enterprise was similar to that of the last. No silver could be obtained; and at length the working was discontinued.

The last company which was systematically organized for the prosecution of this visionary undertaking, consisted chiefly of persons living in the neighboring town of Goshen. They secured a lease of the mine from the New York company, whose term for working it had not yet expired; and began their operations by following down the vein at the first opening, *a*. Neither the length of time they persevered in the working, nor the depth to which they finally attained, are at present known with any degree of certainty; but it is understood that the expense incurred was so great as to occasion the failure of the principal persons concerned.

No value was attached by either of the companies to the Sparry Iron, which forms the main body of the vein; but which appears to have been rejected along with the Quartz, in which it is engaged, as mere rubbish. This seems the more unaccountable, since its great weight, we should suppose, might have led them to suspect its value; and, besides, a report exists, that the workmen of Feuchter were in the habit of obtaining steel from it, for the purpose of repairing their picks and blasting instruments. Thus, with their expectations wholly confined to silver, they entirely overlooked a metal, which, when abundant and favorably situated, affords the surest and the most steady returns of all the substances which the earth contains.

Not long after the mine had been abandoned by the New York company, the Brunsons failed; and at length, the shares, which before had ever retained their original estimation, came to be regarded as nearly valueless. The mine, together with all the adjoining lands, now came into the hands of a Mr. Bacon, an extensive landholder in that country; who formed a plan of working it on his own account. With this view, he contracted with a man to sink the shaft at *a*, five feet lower; for which he was to receive three thousand dollars. This individual commenced the undertaking; but so inadequate were his means for keeping the shaft dry, that he failed before he had completed his contract. Report says, that

the shaft was now sunk to the depth of one hundred and seventy-five feet. Thus far in the history of the mine, the sole object of search had been silver: it now began to be thought of, as possessing some value as an iron mine. Large quantities of the neglected ore, raised by former companies, were carried to Kent, fifteen or eighteen miles distant; and there reduced along with the Haematite ore of that place, with which it is said to have formed a very tough and excellent iron. But the subsequent discovery of more extensive beds of the Haematite in Kent, soon caused this use of the ore to be abandoned.

The last attempt to reduce the ore of Mine hill was made by an individual from Salisbury; who undertook with some persons in the vicinity of the mine to carry on the smelting of the ore at *s*, upon a small stream passing off by the northern part of the mountain. Here he erected a furnace, in the side of a moist hill. On raising the blast a few pigs of iron were obtained at the first operation; but in consequence of the injudicious situation of the furnace, its contents soon became "chilled." They endeavored to re-ignite the materials, by throwing in large quantities of sulphur; but all to no purpose, and so the enterprise was abandoned.

The mine excited no further attention until within ten or fifteen years; when the identity of its ore with the Steel ore of Europe was established by Col. Gibbs and Prof. Silliman. But so scanty was the information relating to the working of the Sparry Iron, both among the iron workers of the country and in books, that no efforts were made for the erection of works and the re-opening of the mine. Thus it remained for several years; when Mr. David J. Stiles, of Southbury, a nephew of Mr. Bacon, the proprietor of the mountain, came forward and purchased one hundred and sixty acres of land bordering upon the vein, with the right of ore upon the whole mountain. Mr. Stiles had previously caused a quantity of the ore to be reduced according to the directions given in Aikins' Dictionary; and from it had obtained very excellent steel, which was manufactured into various cutting instruments.*

In compliance with the wish of Mr. Stiles, I visited his mine upon the 18th of June, 1830, for the purpose of making a mineralogical and geological survey of the same. The ascent of Mine hill, which

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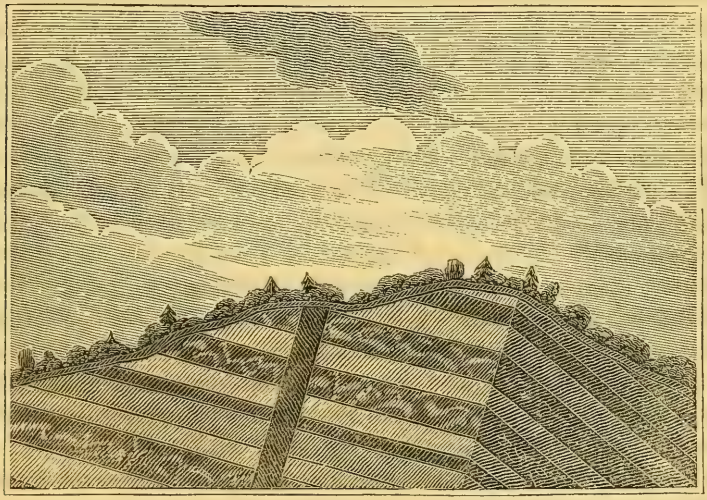
* Among other things, a good pen-knife was brought to me by Mr. Stiles, and a bar of fine grained steel, six feet or more in length; he stated to me that both were made from this ore, and I repose entire confidence in his truth.—*Ed.*

commences at its southern extremity, immediately after crossing the Shepaug river at the bridge *m*, is no where difficult on account of steepness; the roads, however, are extremely rough and much out of repair, having been but little used for the last few years. The mountain is almost entirely clothed with a fine growth of hard wood; the gneiss cropping out, only here and there, in ledges of moderate extent. Wherever it comes into view, it exhibits a remarkably uniform disposition. The direction of the strata is from a point, between S.W. and W.S.W. and N.E. and E.N.E., with a regular dip to a point between N.W. and W.N.W. of 25° or 30°. It presents, likewise, divisions and seams at inconstant intervals, perpendicular to its stratification. Its color is of a fine greyish white, and the great facility with which it is quarried has caused it to be explored for architectural purposes, for the supply of the adjoining country to the distance of thirty miles.*

The vein of Sparry Iron obeys the direction of the cross seams above mentioned; a representation of which is afforded by the annexed sketch: and so direct is it in the course it pursues, that with a



compass, it is perfectly easy to proceed from any one opening in the vein to all the others. In pursuing the vein from *a* down the mountain, the path does not form the nearest route to the river, as is obvious from an inspection of the map; but proceeds along upon the side

* See a notice of this quarry and of the ore, in Vol. ii. of this Journal.—*Ed.*

of the mountain in an oblique direction. For the first one hundred and fifty yards (the distance between *a* and *b*) the rock is concealed by a considerable depth of soil and loose materials; but on reaching *b*, the gneiss comes into view and continues in broken ledges upon the right, sometimes elevating itself twenty or thirty feet above the vein. The immediate vicinity of the vein, from *b* quite down to *h*, is every where strewed over with large masses of the rock, confusedly thrown together; among which, just soil enough has accumulated to give support to a few trees and to the wild laurel, which here thrives in abundance. Throughout this extent, which is at least half a mile, wherever they have removed the superincumbent rubbish, the vein of ore has been brought into view.

With regard to the width of the vein and the nature of its walls, we are informed by persons who were acquanted with the mine during the period of its former exploration, that in the shaft *a*, it varied from six to eight feet and was inclosed by smooth and well defined walls throughout. The mouth of this opening is so much encumbered, at present, with rubbish, that it is impossible to verify this account; but what observations I had an opportunity of making at *b*, offered nothing to contradict it; although the operations here have been so partial as to develop one wall of the vein only, which is that upon the upper side of the mountain. It has been supposed that the vein undergoes a very great enlargement at *b*, in consequence of the cropping out of the veinstone at several places, twenty or twenty five feet from the upper side of the vein; but these masses, though apparently engaged in the main mass of the mountain, appeared to me to be portions of parallel veins and not parts of the great vein of the Sparry Iron. There was no difficulty, however, in tracing the ore six and a half feet from the upper side of the vein, in several places; so as to render it certain that the body of ore does not narrow as it descends towards the river;—a point of some moment to establish, since if this ore shall come to be wrought, it will no doubt be sought at the nearest spot to the river from which it can be obtained.

White Quartz is the only earthy substance found existing with the Sparry Iron in the vein. In some places the Quartz forms seams half a foot wide, through which the Sparry Iron is disseminated in small crystals; but the Quartz may oftener be said to be dispersed through the Sparry Iron,—the latter substance forming the bulk of the vein. In the latter case, the Quartz is in long prismatic crystals; usually, without regular pyramidal terminations. Indeed, the Sparry

Iron is sometimes observed in pieces eight or ten inches in diameter, without any foreign intermixture whatever; which, so far as I had an opportunity of observing, was no where the case with the Quartz. About the shaft at *a*, among the immense heaps of the ore there thrown out, occasional sprinklings of Iron and Copper Pyrites are noticed with the Sparry Iron; also, at a spot a few rods north of the opening, and seemingly gathered into a heap by themselves, I found a few masses of Quartz, through which black Blende was disseminated. As no other specimens of the last substance were seen at any other place, I imagine this to have been the mineral which excited the hopes of silver in those who first engaged in the working of this mine; and in consequence of its being confined to this particular spot, it seems to explain the cause of so much digging at such a height and distance from the river. If this suggestion be correct, the present affords another instance of the appropriateness of the name Blende, (meaning the deceiver) as applied to this ore.

I did not visit the openings at *i* and *k*, as I was informed the vein is at present concealed at both of these places by the falling in of the rubbish; but I received the most satisfactory assurances that considerable quantities of ore were formerly raised at both of these places.

It is usual with this ore where it is exposed to the weather, as has been the fact here with the masses lying about the openings and near the surface of the vein, to undergo a partial decomposition; which is visible in the change of color, lustre, translucency and firmness. A few inches beneath its surface, however, the ore presents its natural aspect. In this condition, it is of a yellowish grey color, slightly inclining to brown, and possessed of a splendent lustre. The fracture, which is effected with the greatest readiness, is foliated; and it takes place, in small masses, in three directions, intersecting each other obliquely, in such a manner as to give rise to rhombic particles. Its texture is such as to afford, on cleavage, rather broad plates; among which, however, are mingled concretions of a smaller size. This variety of ore appears to be what the French miners call *minerai rive orgueilleux*, and which they distinguish from those ores consisting entirely of large, or of small concretions,—the former of which they call *minerais maillats*, and the latter, *minerais rives*. Its specific gravity is 3.71. Before the blow-pipe on charcoal it immediately blackens, cleaves into smaller fragments, and becomes attractable by the magnet, by which, it was unaffected before heating. Its appearance alters rapidly by exposure to the atmosphere: in a few months it pass-

es through several shades of brown, into a brownish or iron black color,—losing, at the same time, its lustre, and becoming opake. Specimens which have been exposed a still longer period, sometimes lose their coherence, and crumble down to a powder.

So numerous and accurate are the analyses which chemists have made of this species, and so uniform have been their results, that a regular analysis of specimens from this place is not requisite: it will be sufficient to remark, that the steel ore always consists of the oxide of iron at the lowest state of oxidation, and carbonic acid, in the proportion of, from 57 to 60 per cent. of the former, and 34 to 36 per cent. of the latter; together with a proportion of manganese from 0.5 to 1.5 per cent., and magnesia and lime, in about the same proportion: these last are, however, less constant in their proportions than the manganese. In those cases where the magnesia exists in larger proportions than is above mentioned, it has been found to offer some obstacles to the reduction of the ore by the economical method of the Catalan forge: this, of late, however, is said to have been obviated, simply by exposing the ore in heaps, for a year or two, to the weather; during which time, it becomes sufficiently decomposed to part with its excess of magnesia.*

I can find no precise statement of the usual yield of iron or steel from the Sparry Iron. The chemist, however, knows perfectly well the proportion of iron it contains. Taking the lowest proportion of protoxide of iron, analysis has discovered in it, from the known composition of protoxide of iron, we have 44 per cent. of metallic iron in the Sparry iron ore. But as we know that the reduction of the ores of iron in the large way, is attended with a loss, varying from one third to one half of the metal, it would not be far from truth to place the yield of this ore at 25 or 30 per cent. The quantity of charcoal required to obtain 100 pounds of iron or steel, is stated to be, from 500 to 540.

The situation of this deposit of ore, as respects the vicinity of water and wood, is such as, in a very remarkable manner, to facilitate its being wrought. And in the first place, as regards a stream of water adapted to the construction of those hydraulic machines which

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* The removal of the magnesia under these circumstances may be attributed to the natural oxygenation of the sulphur contained in the Pyrites disseminated through the ore,—thus giving rise to sulphuric acid, which, combining with the magnesia, forms the well known compound, called Epsom salts; which is conveyed away from the ore by the rains to which it is exposed, as fast as its formation takes place.

would be required, the Shepaug river, which passes directly under the base of the mountain, (and so near as only to leave room for a road,) will furnish every facility that can be desired. It affords a never failing supply of water; and upon its banks a saw and grist mill are erected directly at the foot of the mountain. The width of the river is four or five rods, and its average depth three feet. It is supplied from the Litchfield pond or lake, ten or twelve miles northward, from which it flows with a rapid fall between two ranges of mountains, which, for several miles above Mine hill, rise very abruptly from its banks to the height of three hundred and fifty or five hundred feet. The sides of these mountains are clothed with a heavy growth of hard wood, extending quite down to the water's edge. After the stream passes under Mine hill, a little interval land begins to appear, and continues for two or three miles south: upon this and the more gentle ascent upon the east of the stream, exist several well cultivated farms. The land, however, which is situated northward, belongs to the farmers who live upon the mountains, distant about a mile or a mile and a half from the stream. From these circumstances, it is apparent, that coal lands of the best quality and near by, may be obtained at the lowest rate. Tracts, containing thousands of acres, may be purchased, as favorably situated as could be wished, at a price varying from three to ten dollars the acre, according to its fitness or unfitness for agriculture after clearing.

The communication between Mine Hill and the Housatonic, a distance of only four miles, is easy for land carriage; and from a junction of these rivers, boat navigation exists to Derby: to which last place sloops ascend. The means of living and of obtaining mining labor, about the mine, would be abundant and cheap. The steel afforded from the ore, would allow of the establishment of manufactures of saws, steel springs, sythes, and coarse cutlery in general; all of which are carried on in France, in connexion with such mines, and which the wants of the agricultural country in the immediate vicinity, and the easy access to New York, must render exceedingly profitable.*

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* The following statements respecting the extent and value of the Sparry Iron, and of the steel to which it gives rise, are extracted from two of the most recent and respectable treatises upon the application of mineralogy to the arts.

"Sparry iron is a rich ore, and one which is sought after, because it is easy to melt, and affords steel directly. It yields easily to the treatment of the Catalan forge; a method uniting economy of time and of combustible in the highest degree."

Considering, therefore, the inexhaustible supply of the ore and the ease with which it may be raised,—the facilities of wood, water and labor,—and the easy transportation to market, I am authorized by the present proprietor to submit it to the attention of capitalists, whether, a surer investment of capital can be made in our country; or one, which, on the whole, would prove more conducive to our national prosperity, than that above described.

Salisbury Iron Works.

It may not be generally known that the Iron mine of Salisbury has, for a considerable period, been one of the most important in our

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"The Sparry Iron is not so generally distributed in nature as could be desired; nevertheless it is explored in France, in numerous veins in the environs of Baigorry, department of the Basses-Pyrénées, by means of the Catalan forges established in the neighboring departments.

"At Allevard, near Grenoble, in the department of Isère, two hundred miners are occupied in working this ore, of which the iron, fit for the fabrication of steel, furnishes the important steel manufactory of Rives, in the same department.

"In Styria and in Carinthia, this ore occurs in beds and powerful veins, and even forms an entire mountain at Eisenœrz and at Erzberg, from whence comes the excellent steel brought into France from those countries, and which serves for the fabrication of sythes, which the French are now themselves beginning to imitate from their own natural resources, so as nearly to take the place of the German steel.

"In Switzerland, also, an enormous mass of this ore is explored, known under the name of *stahlberg*. Finally, it exists, likewise, in the Hartz, and in Siberia; in all the situations where it abounds, it always becomes the basis of the most important manufactures in steel."—Brard, Minéralogie appliqueé aux Arts, tom. I, p.377, et. sq.

"Natural Steel is made at once from sparry iron in small blast furnaces, which from their being much used in Catalonia, in Spain, are called Catalan forges. The steel produced in them is good steel for ploughs and similar machines; that with three marks is excellent for springs and sword cutlery."

"The most esteemed natural steel made in Germany, is that of Styria; it is usually sold in chests or barrels, two and a half to three feet long. Its grain is even, close, and fine, but when polished, it shews fibres, cinders and threads, from which even this steel is not entirely free." "Files and the best kind of tools are usually made of this steel in Germany." "The French have also manufactured natural steel for a long time; but it is only lately that they have begun to improve their quality and to attempt to rival the German steel. The best French steel works are those of Rives, in the department of the Isère, which is used for large cutlery, and might perhaps be used for the finest. The steel of Berardière is used for all kinds of springs, as also for cuirasses, which are usually made of iron; but those of this steel well forged, offer four times the resistance, although equally light, and not dearer. The natural steel of Le Hutte, department of the Vosges, is esteemed excellent for saws. Good natural steel is also manufactured at Neronville, in the departments of the Niévre." "The steel brought from Bombay, by the name of *wootz* or Indian steel (of which the Damascus sabres are made,) is, also, a kind of natural steel."—Gray's Operative Chemist, p. 684, et sq.

country, both as respects the quantity and the quality of the iron it has afforded. The following notice relates principally to the statistics of the iron works of that place and its immediate vicinity; the items of which were obligingly communicated to me by Mr. Holley, one of the principal proprietors in these establishments.

The ore bed, which supplies these works, is situated in the western part of the town. It covers an area of several acres, forming a moderate elevation; and is hence called "ore hill." The common notions concerning its origin find little support in the appearances it presents. It has frequently been supposed to be of more recent formation than the mica slate rock to which it is immediately contiguous; and it is maintained by some, in consequence of the stalactitical and fused like aspect of its ore, to have been subjected to a melting heat. That the entire deposit possesses a tolerably uniform stratification, however, except in places of limited extent, where the unusual preponderance of the ore has created slight disturbances, the observer who descends into the different excavations cannot fail of discovering; and by comparing the direction and dip of the strata with those of the adjacent mica slate, he will find them perfectly coincident;—thus affording the most satisfactory evidence that they are contemporaneous and identical formations. In order to form a more just idea of the origin of this, and of all similarly situated beds, and to obtain an explanation of their present condition, we are only to conceive that the parent menstruum of the mica-slate in these particular localities, abounded with the hydrated peroxide of Iron, and that geodes of various dimensions, and more or less lined with stalactites, were formed from the union of capillary crystals, according to the well known laws of crystallization, and laid down with the particles of mica and quartz into strata; and that the free infiltration of water into a cavernous or geodiferous rock of such a character has produced, as might be expected, decomposing effects to a very considerable degree, so as to convert its materials in part into clays and ochres, as we actually find them at the present time.

This bed of ore has been opened about one hundred years. The grant to the original proprietors bears the date of October 27, 1731. During the first forty or fifty years, the quantity of ore raised was small; but from that period to the present, from four to five thousand tons have been raised, annually. At first, no duty was paid to the owners of the ore; afterwards the sum of twenty-five cents

per ton was required, then forty-two cents, fifty cents, sixty-seven cents, one dollar, and for the last ten or twelve years, the duty has been one dollar twenty-five cents the ton. One half of the ore bed is owned by the Livingston family of Columbia county, N. Y., one quarter by Wm. Ashley, of Sheffield, Mass., and the remainder is held by a number of individuals in small shares.

The expense of raising the ore is one dollar seventy-five cents per ton. This business is carried on by small independent parties, who, to the number of six or eight, work together in a pit or excavation by themselves, blasting, picking and throwing the ore into heaps, in readiness for transportation to the furnaces. One general agent on the part of the proprietors of the mine, superintends the weighing in all the excavations. Another class of men undertake the transportation of the ore; for which they are allowed sixteen cents per mile for every ton's weight.

The principal furnaces to which it is carried, are as follows; viz. 1. Chapin, Sterling & Co.'s furnace, situated in the north part of Salisbury, seven miles from the ore bed, upon the outlet of Chapin's pond, which empties into the Housatonic river in Sheffield, Mass.; 2, the Salisbury Iron Company's furnace at Mount Riga, in the north-west corner of Salisbury, at the outlet of two ponds, four miles from the ore bed; 3, Holley & Coffing's furnace, in the west part of Salisbury, upon the outlet of Wanscopomic pond, two miles east of the Ore hill;* 4, Canfield, Sterling & Co.'s furnace, on the Housatonic river, just below Canaan falls, between six and seven miles from the ore hill. To this list, must also be added, the new furnace at Limerock, in the south-west part of the town, now in construction; and which is to be supplied with ore from the ore hill. The first forge built in this part of the country, was erected on this site, more than one hundred years ago. Its distance from the ore hill is nearly five miles. In all these places, the ore is reduced in high charcoal furnaces, and yields upon an average fifty per cent. of Pig-iron.†

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* This is the oldest furnace in the vicinity, and was built nearly seventy years ago.

† In the Messrs. Hunt's establishment in South Canaan, which is also supplied with ore from ore hill, and where large anchors for the United States' navy are made, the high furnace is not employed; but the tough iron is obtained directly from the ore by means of the Catalan forge.

The annual yield of these furnaces, in Pig-iron, may be stated as follows.

No. 1. from 400 to 600 tons.
2. 400 tons.
3. from 500 to 600 tons.
4. from 500 to 800 tons.

The new furnace at Limerock will make from three to four hundred tons. Formerly, a great proportion of this iron was sold in pigs; but for the last few years it has principally been converted into bar iron at the furnaces where produced, or at Winsted, in the forges of S. Rockwell, James Boyd & Son, and Reuben Cook. At the works, it formerly commanded thirty-five or forty dollars the ton; but at present it sells at thirty or thirty-two. The Salisbury Iron Company have two forges at Riga, containing seven fires, an anchor and screw shop with two fires, a lathe for turning iron, and a trip-hammer shop. They have also at Limerock a forge with six fires. This company makes about four hundred and fifty tons of wrought iron annually, which is made into the following articles; viz. bar iron for musket and rifle barrels, and for common uses for the country blacksmiths; axletrees, crow-bars and tires for wheels; irons for grist and saw mills; anchors, large and small; shafts for steam engines, and manufactories of all kinds; large screws for clothiers, paper-makers, and for pressing bales of cotton and hay. Canfield, Sterling & Co. have one forge with six fires; and another with two, and an anchor shop. They make from two hundred and fifty to three hundred tons of tough iron annually; and furnish most of the articles mentioned above, except screws.

The best Salisbury iron has obtained a decided preference over all other iron, either foreign or domestic, for the construction of musket and rifle barrels; and is extensively employed for these purposes at all our principal gun-factories, both public and private. The annual consumption at the following manufactories is as follows.

Public armory at Springfield, Mass. from 100 to 125 tons.
" Harper's Ferry, Va. 100 tons.
Gun-factory at Whitneyville, Conn. from 40 to 50 tons.
" " Middletown, 40 to 50 "
" " Pittsfield, Mass. 40 to 50 "

The expense of transportation from Salisbury to the Hudson river is five dollars per ton. That portion of iron destined for the New York market, and for the south and east, goes to Poughkeepsie;

while that which goes to Albany, and farther north and west, is carried to Hudson.

Besides the great bed of Brown Iron stone at Ore hill, there are numerous other deposits of the same ore in Salisbury and the neighboring town. One of them, called Davis' bed, occurs two and a half miles north-east of the ore hill; from which there was formerly a considerable quantity of ore taken for forges and furnaces: but, it is at present neglected. Two or three others are found in the north part of the town, and north-west of Chapin, Sterling & Co.'s furnace; they make iron of an inferior quality, however, and are not much used at present, though it is understood, that they are capable of furnishing considerable quantities of ore, if it shall, from the exhaustion of ore hill, ever come to be wanted. The towns of Amenia and Beekman, in the State of New York, furnish ore to three furnaces in Kent, which make excellent iron. There is an abundance of ore in Kent also, which furnishes three other furnaces in that place, two of which are upon the Housatonic, and the other upon a branch of it; but the iron they produce is less tough and malleable than that of Salisbury.

Art. X.—*Remarks on Professor Eaton's "Observations on the coal formations in the State of New York;"* by David Thomas, Civil Engineer, Corresponding Member of the Linnæan Society of Paris, &c.

No person has so minutely examined as large a portion of the United States with reference to its Geology, as Prof. Eaton; and his sagacity has equalled his industry and zeal. Probably none of his writings is more interesting and important, than the article now before me, although some of the observations might be advantageously extended, explained, and perhaps corrected.

"Mr. C. Van Rensselaer and myself have traced the slate rock which embraces the bituminous coal of Tioga to Seneca and Cayuga lakes, also down those lakes to their outlets." I have not noticed this sentence on account of an error in the last clause, for Prof. E. will recollect that limestone occurs on the shore of the Cayuga for nearly nine miles above its outlet; but I wish to ask whether he considers the slate which appears on the shores of our lakes as the same

stratum which embraces the Tioga coal? or whether he only means that it belongs to the same (third greywacke) formation? I had been induced to believe that our slate is a different stratum, from considering that *there is a general dip in all our rocky strata to the south.** It is also to be observed, that our slate is overlaid by harder rocks, which contain a much greater portion of siliceous matter; and are so little affected by exposure to the weather, as to have been quarried for building stone, in particular localities. Much of this kind, on account of its smoothness, durability, and regular form, has been taken down the Seneca lake to Geneva; and some beautiful pieces were used in constructing the old stone locks on the Seneca outlet. The hill immediately south of Ithaca village, which almost closes the valley of the Cayuga, also contains a much harder rock, and appears to cover up the last traces of our soft slate in a southerly direction.

These circumstances render it *not improbable* that our slate continued with the same dip, underlays the Tioga coal, which is probably seven hundred feet above the Seneca lake, at a depth of many hundred feet; and that the slate traced by Prof. E. belongs to different strata, separated by harder varieties of greywacke.

How far our rocky strata may be traced to the south, I have yet to learn. In the valley of Towanda creek, twenty miles below Tioga Point, near an extensive deposit of bituminous coal, a *red rock* occurs; and salt has been manufactured in that vicinity. Red sandstone and salt springs also occur in the elevated region to the southwestward. I have procured salt from those waters.

Is that saliferous rock in the same stratum as the saliferous rock of this district? If it is, our incumbent strata (limestone, slate and greywacke) must terminate north of the Towanda; and the saliferous stratum, south of our lakes, must very considerably ascend, at least on its upper surface.

When we discovered the carburetted hydrogen in the Erie canal, six miles east of Lockport, I was much surprised, as all the fountains of this kind which I had previously seen, were in the pyritiferous slate. I accord with Prof. E. however, in his views on this subject.

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* The idea appears not to have occurred to Prof. E. at the moment of writing, for he says, "*The layers of this* [*carboniferous*] *rock are always horizontal or nearly so.*"

But the issues, "near the village of Canandaigua, and near the Cayuga lake," ought to be noticed as belonging to another formation.

I have observed bitumen in the limestone at Lockport;* also in the limestone at Seneca Falls; and during the burning of a lime-kiln one mile south of Union Springs, I have noticed in a calm evening that the air was scented to a considerable distance with bituminous vapor. These facts may be considered in accounting for the gas which springs from the limestone above Niagara Falls.

The much greater abundance of carburetted hydrogen which occurs in the pyritiferous slate; the actual discovery of some coal, together with the great thickness of the overlying formation, induce me to doubt whether this gas rises from below the saliferous rock. At Bristol, in the channel of a small stream, eight miles south westerly from Canandaigua,—and in a ravine, one mile north-easterly from Aurora village, nearly on the same level, and perhaps with twelve hundred feet of intervening rock, the quantities which issue are very great, and at either place might be profitably used, as it burns very freely. Near my dwelling, one mile north of the latter locality, and three hundred feet above the Cayuga lake, in cutting a ditch five feet deep, (one foot through the slate, among *septaria*) much carburetted hydrogen rose through the water.

As Prof. E. in his estimates, appears not to have considered the dip of the strata to the south, I apprehend that considerable additions ought to be made to the depth of his proposed borings.

To conclude, if Prof. E.'s health and business would permit him to visit the valley of the Towanda, he probably might discover whether that red sandstone is the same as the saliferous rock of New York? Whether it lies under or over the bituminous coal? and he possibly might ascertain whether the inclination of our limestone and pyritiferous slate, south of our lakes, is changed? Whether these strata terminate with bevelled edges against the ascending saliferous rock? Or whether the last mentioned rock belongs to another formation? The determination of these points must be deeply interesting to geologists.

Greatfield, Cayuga Co. N. Y. 11th mo. 15, 1830.

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* The author, in a letter accompanying his communication, says, that not having a specimen by him, at the time he was writing, it is possible that the substance observed, was bituminous coal; it exhaled a distinct bituminous odor on being heated; and as regards the views expressed in the paper, it is perhaps of little importance which it was.—*Ed.*

ART. XI.—*Electro-Magnetic Experiments;* by Dr. G. MOLL, F. R. S. E. M. A. S. Professor of Natural Philosophy in the University of Utrecht.

(Communicated by the Author for Dr. Brewster's Edinburgh Journal of Science.)

IN the *Transactions of the Society for the Encouragement of Arts, Manufactures and Commerce*, Mr. Sturgeon of Woolwich, has given a description of an elegant and curious apparatus, with which many striking electro-magnetic experiments may be performed. Among these, is a soft iron wire, bent in the form of a horse-shoe, wound round with copper wire. The ends of this copper wire, being made to communicate with the opposite poles of a galvanic apparatus, the iron becomes a strong horse-shoe magnet, capable of supporting a heavy bar of iron. On lifting the connecting wire out of the cups, the force is immediately destroyed, and again restored on plunging the connecting wire of the battery again in the cups.

This apparatus I saw in 1828, at Mr. Watkins', curator of philosophical apparatus to the London University; and the horse-shoe, with which he performed the experiment, became capable all at once of supporting about nine pounds.

I immediately determined to try the effect of a larger galvanic apparatus on a bent iron cylindrical wire, and I obtained results which appear astonishing, and are, as far as the intensity of magnetic force is concerned, altogether new. I have anxiously looked since that time, into different scientific continental and English journals, without finding any further attempt to extend and improve Mr. Sturgeon's original experiment.

I procured from Mr. Watkins a soft iron wire, bent in the shape of a horse-shoe. The length of the horse-shoe was about eight and a half inches, and one inch in diameter. A copper spiral wire was twisted round this iron from right to left (sinistrorsum.) The diameter of this wire was about one-eighth of an inch, and it was twisted or coiled eighty-three times round the iron. The ends of this wire were made to plunge in cups filled with mercury, in which the connecting wires of the zinc and copper poles of a galvanic apparatus were likewise immersed.

The weight of the horse-shoe, together with its surrounding spiral wire, was about five pounds.* A piece of soft iron, constructed in the same form as the iron which connects the ends or poles of a horse-shoe, or armed magnet, weighed about one and a quarter pound or six hundred and thirty grammes.

The galvanic apparatus used consisted of one single copper trough, in which a zinc plate was immersed. The acting surface of this zinc plate was about eleven English square feet.

When the conducting fluid was poured into the trough, the horse-shoe immediately became a strong magnet, capable of supporting about twenty-five kilogrammes or fifty pounds.

If weights are added with some caution, this *extempore* magnet may be brought to support seventy-five pounds or thirty-eight kilogrammes.

The south pole of the horse-shoe magnet is on that side on which the copper spiral wire is dipped in the cup connected with the zinc plate; the north pole, of course, is on the side communicating with the copper trough.

We call the *north pole* of a magnet that end of it which, in a magnetic needle, points to the north.

The rapidity with which such a powerful magnet, capable of supporting seventy-five pounds, is produced, is truly astonishing. With equal celerity the magnetism is destroyed and the poles reversed, merely by shifting the connecting wires of the battery from one cup to another.

The magnetism of this horse-shoe is not, however, instantaneously destroyed, merely by taking the connecting wires out of the cups, and without shifting them from one cup to another. Instead of suspending from the magnet the maximum of what it is able of supporting, if a lesser weight, twenty pounds or ten kilogrammes be attached to it, the magnet will not cease to support the weight, immediately after removing the wires from the cups, but continue to attract the weight for a longer or shorter time, according to the strength of the magnet. The heavier the weight which remains thus suspended, the shorter will be the time after which it falls down.

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* The pounds mentioned here, are Dutch weight, of sixteen ounces in the pound. This is somewhat heavier than *avoirdupois*. Two pounds are a little less than one kilogramme. But if no great accuracy is required, two pounds may be estimated equal to one kilogramme.

If the iron bar which so connects both poles of the magnet is supported by the hand, whilst the wires of the battery are removed from one cup to another, the velocity with which the poles are reversed may be actually *felt* by the duration of the impression of the weight on the hand. This duration is certainly much less than one-tenth part of a second.

If we compare the velocity with which the poles are changed, only by transferring the wires from one cup to another, with the trouble and time required to change the poles of a common magnet, capable of supporting seventy-six pounds, it becomes rather difficult to bring the rule of Horace, *Nil admirari*, in actual practice. If the poles of the horse-shoe are connected, not by the heavy iron rod, or supporter, but by a slender steel needle, the poles may be reversed before the needle by its weight overcomes the resistance of the air. When the wires are shifted, a transient motion is perceptible in the needle, but it does not fall.

When the horse-shoe is loaded till the weight falls, its magnetic force will be found considerably weaker, and some time must elapse before it becomes again capable of carrying the same weight as before. It is well known that common horse-shoe magnets, when allowed to drop their load, are considerably weakened, and often never recover their former strength.

In the experiments which I am now relating, the strongest action of the horse-shoe takes place the instant when the trough is filled and the connection is made.

Although this horse-shoe is only possessed of a transient magnetic force, the duration of which is limited to that of the galvanic action of the battery, it is capable of communicating strong and lasting magnetism to hardened steel bars and compass needles. If a steel bar be rubbed several times from end to end along the poles of the horse-shoe, lasting magnetism is communicated to the bar, exactly as could be effected by any other strong horse-shoe magnet. By touching the horse-shoe in a contrary direction, the magnetism of the bar may be destroyed, or the poles reversed at pleasure. In a similar way, strong magnetism may be impregnated in compass needles, or their poles reversed.

It is a well known fact, that lightning often destroys the action of compasses on ship board; and there are even instances upon record of serious accidents being occasioned by the poles of compass needles being inverted by the electricity of lightning. Prudent navigators

provide themselves often, on long voyages, with a set of magnetic bars, by means of which the strength of their compass needles, if impaired or lost, may be restored. But it is possible, nay it is probable, that the same stroke of lightning which destroys the magnetism of the compass needles may also spoil that of the steel bars. A copper trough of modern dimensions, a zinc plate, a little sulphuric and nitric acid, or, if that was considered too dangerous, some sal-ammoniac, and withall a soft iron wire, bent in the shape of a horse-shoe, and wound round with copper wire, would constantly insure the certitude of restoring magnetism on ship board.

After making these experiments, I was anxious to know if the power of the magnet was susceptible of still farther increase by augmenting the strength of the galvanic apparatus. A second trough, the acting superficies of which was about six square feet, was added to the first. The zinc plate of one trough was connected with the zinc of the other, as also the copper of the one with the copper of the other. Thus the superficies brought to action was about seventeen square feet. But the horse-shoe magnet had acquired, it would appear, its maximum of strength, for its magnetic force was not materially increased by this augmentation of galvanic power.

I afterwards tried, with the same view, the powerful galvanic apparatus of Colonel Offerhaus, which I formerly described in Dr. Brewster's *Journal.** But no increase of galvanic power was capable of increasing the strength of the magnet beyond a certain limit.

Another iron wire, bent in the shape of a horse-shoe, and similar in every respect to that with which the preceding experiments were made, was surrounded with a spiral coil of *brass*, twisted from left to right, (dextrorsum.) The effect was exactly the same as with copper wire, except that the spiral being wound to the right hand side, the north pole was, as might have been anticipated, on the side connected with the zinc.

A brass horse-shoe, wound round either with an iron, a brass, or a copper wire, did not show the least effect: I did not, indeed, expect the least result from this experiment, which was made at the instance of a friend.

It has been shown by the former experiments, that it is of little consequence whether a brass or a copper spiral be used. An iron

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* Edinburgh Philosophical Journal, t. 6, p. 52.

spiral was tried in its turn, but the precaution was taken of coating the horse-shoe with silk. The iron spiral, wound to the left hand, was three-sixteenths of an inch in diameter; the weight of the apparatus about three kilogrammes, or six pounds, the iron, connecting the ends of the horse-shoe, about one and a quarter pound. The apparatus thus arranged proved stronger than the former; it supported eighty-six pounds, or forty-three kilogrammes.

Encouraged by these results, I increased the size of the horse-shoe, with a view of investigating whether any considerable augmentation of power might be thus produced. I had a horse-shoe prepared of about twelve and a half English inches high, and two and a quarter inches in diameter. A brass spiral of one-eighth inch diameter was wound forty-four turns from right to left round this strong bar. The weight of the apparatus was about thirteen kilogrammes, or twenty-six pounds. The connecting bar of the apparatus weighed about four pounds. With an acting galvanic surface of eleven square English feet, the magnet supported sixty-seven kilogrammes, or one hundred and thirty-five pounds weight.

The horse-shoe was afterwards coated with silk, and an iron spiral wire substituted for that of brass. The apparatus then *supported one hundred and fifty-four pounds*, but I could not succeed in making it carry an anvil of two hundred pounds weight.

It is well known that small magnets, generally speaking, are stronger in proportion to their size than larger ones. I procured a small horse-shoe, coiled round with brass, and weighing in all two pounds. It supported about six pounds.

Vallemont* relates that S. Augustine, was considerably alarmed and terrified, by witnessing some magnetic experiments, amongst which was a magnet supporting several iron rings, suspended from each other. The reverend father does not appear to have been deeply read in Greek philosophers and Latin poets, else he might have known, that the experiment which surprised him so much was known in the days of Plato, and described by Lucretius. S. Augustine would probably have been still more alarmed if he had seen magnets capable of supporting one hundred and fifty-four pounds, formed in an instant, and their poles taken away or altered with the velocity of lightning.

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* Vallemont, *Description de l'aimant, qui s'en formé à la pointe du clocher neuf de N. D. de Chartres*, p. 164.

The poles of this large magnet were altered, restored, or destroyed with prodigous speed. It proved exceedingly well adapted to communicate a strong magnetism to bars of steel or compass needles.

My next trial was, whether it would be possible to increase the power of a common horse-shoe magnet of hardened steel. A magnet of this description, eight inches and a half high, weighing about eight pounds, having lost much of its former strength, and capable only of supporting about five pounds, was twisted round with brass wire. It was exposed to galvanic action during several hours, but its strength was not increased in the least degree.

I am far from supposing that the utmost force which I was able to produce by galvanism is the limit of what may be done, and I am continually trying experiments, with a view of increasing the magnetic force already produced. At all events, it appears that the production by galvanism of a magnet capable of supporting one hundred and fifty-four pounds, is a curious fact, which a few years ago could be little anticipated.

I took some pains to look over different books, in order to find accounts of large magnets, either artificial or natural; my trouble, however, was not well rewarded. I found but few and scanty accounts of large magnets.

An old Dutch traveller and painter, *Andrees de Bruÿer*, speaks of an immense natural loadstone, kept in the museum of Florence. Lalande, in his *Voyage en Italie*, gives some further account of this magnet; but it is, as appears, unarmed, and therefore little can be said of its real strength.

One of the largest natural loadstones which I have seen is in the museum of Teyler at Haarlem. It commonly supports one hundred and fifty pounds weight; but the connecting iron piece, the dish on which the weight stands, &c. may be estimated at least at fifty pounds. Thus the ordinary weight which this loadstone sustains is two hundred pounds. But Mr. Van Marum asserts, that it is capable of carrying fifty pounds more, without dropping its load. The Teylerian loadstone, therefore, the largest at least in this country, carries two hundred and fifty pounds.

Another loadstone in the same museum sustains fifteen kilogrammes or thirty pounds.

A loadstone in the collection of the Society Felix Meritis at Amsterdam carries fifty pounds or twenty five kilogrammes.

The artificial magnets which were made by the Abbé Lenoble were celebrated in their time. The largest weighed nine pounds two ounces, and supported one hundred and five pounds French poids de Marc.

Galileo, in his younger days, applied himself much to the making of magnets; and Castelli, his pupil, speaks of one which weighed only six ounces, and supported fifteen pounds.

Mr. Park says* that one of the Emperors of China presented to Toao V. king of Portugal, who reigned from 1750 to 1777, a large natural magnet carrying two hundred pounds.

Our countryman Dr. Ingenhouss, made very small artificial magnets, carrying about a hundred times their own weight.

Professor Allamand of Leyden had a magnet, supporting from eighty to one hundred and twenty pounds. It is now in the collection of the Rotterdam Society of Arts and Sciences.

Coulomb made artificial magnets, weighing ten kilogrammes or twenty pounds, and supporting fifty kilogrammes or one hundred pounds.

A certain Keilius or Keil, a German doctor, made, it is said, magnets of extraordinary power, supporting in some cases two hundred and fifty pounds. A horse-shoe magnet of this man weighed, it is asserted, six pounds, and supported seventy pounds.

It appears from this that the magnet which I made by galvanic force was inferior only to that of the Teylerian Museum, that of the Emperor of China, and to that one which Dr. Keilius is said to have made.

Before the discovery of Dr. Oerstedt, it was a matter of doubt among natural philosophers, whether any magnetism could be produced by galvanism. Now, magnets nearly equal to the largest in existence are produced instantaneously by the mere application of galvanic power.

When Dr. Oerstedt first published his brilliant discovery, it was observed by some that the new facts which were then daily brought to light, added very little to the stock of our knowledge. It was said that these facts were unconnected with each other, and with any others previously known. I am very far from approving these views; and I am much more inclined to believe that the series of new facts discovered within the last years, clearly points out a more intimate connection between phenomena which formerly were held to be en-

* Park's *Chemical Catechism*, p. 405.

tirely independent of each other. Perhaps a few years later, and it will be generally known that many of these disjoined facts are produced by the same general cause.

Since the days of Gilbert, it has been allowed that the earth acts on magnets near its surface, as one magnet on another. Every one knows what is meant by the *magnetism of the earth.* Thus the globe of the earth acts as a system of magnets whose poles are placed in a certain determined position with respect to the terrestrial poles.

But a magnet, when acted on by galvanism, may be made to revolve round its axis. May not, therefore, the revolution of the earth, of that immense magnet, be effected by galvanism by a similar cause?

Magnetic inclination and declination may be produced by galvanism. The magnetic needle is subject to inclination and variation on the surface of the earth. A magnet revolves on its axis when under the influence of galvanism; the earth revolves also on its axis.

The light produced by galvanism is unrivalled by any other artificial light. No argand or any other lamps, or gas light, can be compared to that emitted by charcoal placed between the poles of a large galvanic apparatus. The light of the sun alone is superior to it. Galvanic light in a vacuum will extend itself to greater distances, and its appearance is strikingly similar to that of that light which is observed in the vicinity of the magnetic poles of the earth, of the aurora borealis.

To complete the analogy, the emission of this polar light has an influence on the magnetic needle, which cannot be doubted after the repeated experiments of M. Arago.

Would it be entirely absurd to suppose that aurora borealis is produced in those places where the galvanic force, which determines the rotation of the earth, is communicated to the globe?

No lamp nor gas light acts on the Bolognese stone, nor on Canton's phosphorus. These bodies imbibe light only by exposure to the sun's rays. But the same effect may be produced by exposing the Bolognese stone or Canton's phosphorus to the action of galvanic or electric light. Thus galvanic light alone possesses this analogy with sun light; and galvanic force is alone capable of producing on a smaller scale the same effects which are dependent on the action of the sun's rays.

Since Mrs. Somerville repeated Morrichini's experiments, and pointed out the method of making them with certainty of success, it is scarcely possible to doubt the power of the sun's rays refracted through a prism of magnetizing steel needles. Thus magnetism is

alike produced by sun light, and by galvanic influence. Therefore, it would not appear unreasonable to doubt whether some analogy does not exist between the sun and that force which so strongly affects the magnetic needle.

I need scarcely mention how extended is the range of galvanic action in almost every part of chemical investigation. There is hardly one phenomenon known in chemistry which is not more or less connected with electro-magnetism. In every chemical action, the agency of that force is perceptible, which appears to pervade all nature, and whose influence seems to vivify the mutual action of existing bodies. Thus it would appear that the phenomena of galvanism, far from being disjoined and unconnected with other classes of corpuscular action, may form the links of that chain by which the mutual action of bodies is joined together.

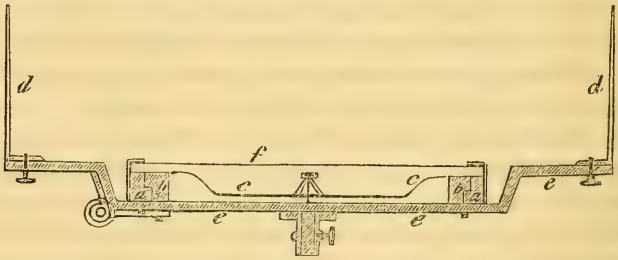
Art. XII.—*Notice of improvements in the Surveyor's Compass, constructed by* Thomas Kendall, of New Lebanon, N. Y.

The object of the artist in the construction of this instrument has been to simplify and unite in one instrument, of moderate price, all that is necessary or convenient in common practice. The improvement, in the form of the needle, has been before the public more than twenty years, and is approved by all who have become acquainted with it. By giving it the form represented in the figure, the advantages of having the points of the needle in a line with the point of the pivot on which it rests, and of having the centre of gravity very low, are secured; the needle settles with more uniformity, and the vibrations of the lower part of the needle continue, and are plainly seen some time after the points are apparently at rest, giving the assurance that the needle is free and has settled correctly. Contrary to the theories and practice of many, Mr. Kendall has uniformly made his needles with their weight as far removed from the center as circumstances would admit, on the principle that attraction is according to the quantity of matter and acts on the needle as a *lever*, and experience has confirmed the correctness of this opinion. Needles on this plan have been frequently called for by those who were dissatisfied with their old needles, the weight of which was greater near the centre. For ascertaining correctly the variations in degrees and minutes, two limbs are united, one within the other; the outer limb is stationary, being secured fast to the bar of the compass, with

a graduation upon it of twenty degrees each side of the meridian line; the inner limb, on the outside of which is a nonius graduation to five minutes, which comes in contact with the graduation on the outer limb, and on the inside, the usual graduation for the needle, the glass covers both limbs, protecting from the atmosphere and giving the nonius graduation the advantage of being silvered and retaining its whiteness. In this construction the advantage is gained of being assured that the centre of the limbs, centre of motion of the inner limb and needle, and the centre of the graduations are one and the same.*

A level is attached to the compass, and a graduation for taking altitudes, by which the practitioner, when his compass is level and fitted to his course, is enabled to take the level or angle of ascent or descent of any object in his course, from his station, without any additional machinery or adjustment; to effect this, two apertures are made for the eye in one of the sights, one at the top, for looking down hill, and one at the bottom, for looking up hill; these apertures are the centre of arches of which the other sight is a tangent, and there is a graduation on each side next to the eye to correspond with the degrees of the arches; by looking through the small aperture, the point of the graduated sight, in a line with the object, gives the true angle required.

The annexed figure, in connexion with the above description, will sufficiently explain the instrument. The artist is now making arrangements to be ready to execute orders at very short notice, for compasses containing all or parts of the improvements, as may be wanted. Also to graduate the sights of old compasses for taking altitudes.



The figure represents the compass as if dissected by a line through the centre. *a* outer stationary limb; *b* inner moveable limb; *c* needle; *d* sights; *e* bar of the compass; *f* glass.

* With a very little additional expense and variation, this instrument may be transformed into a Theodolite having two pairs of sights, one pair attached to the outer limbs, which is to be moveable and the inner limb stationary.

ART. XIII.—*Remarks on Arsenic, with drawings of the color of its precipitates formed by reagents applied to them; by* Dr. LEWIS FEUCHTWANGER.

IN subjoining the drawings of the precipitates, formed by the different tests for arsenious and arsenic acid, the greatest part of which are copied from a German periodical work, called the Laboratory; I cannot forbear to announce, at the same time, some results to which experience has led me during the last five years; to these I shall add some new facts of a case in which, during last summer, I had the honor to assist Dr. Hare, in Philadelphia; and I may be allowed to begin with the medico-juridical process, and with my general views for detecting and proving the existence of arsenic. If an individual has been poisoned, we have in the first place to observe the four following points.

1. The person being yet alive, whether he has partly thrown up the poison by vomiting? In this case the vomited materials can be examined.

2. If the individual is alive and did not vomit any thing? We have then to give an emetic for the purpose of obtaining the contents of the stomach.

3. The individual may be living, but the vomited matters may have been thrown away; the physician has then to observe the symptoms of the whole disease.

4. But if the individual is dead, we must proceed to the dissection of the stomach, the duodenum and the bowels, which with their contents are to be taken out.

By presuming now that the poison was arsenic, we examine:

(*a.*) Whether the arsenic has been in solution in the stomach;

(*b.*) In the state of a powder, as white arsenic;

(*c.*) In the form of a sulphuret, as Orpiment;

(*d.*) In the state of an arsenide, as Scheel's green;

(*e.*) Or in its metallic state.

Do we find it in the form of the two last mentioned? Then it is insoluble in water, and the whole must be boiled with aqua regia, filtered while hot, neutralized with ammonia, and then treated in the manner I shall hereafter describe.

If it was a sulphuret of arsenic, we must then boil it with nitrous acid to form the arsenious acid.

If it is already in the state of arsenious acid, it ought to be boiled, filtered and then tried.

But if we do not find any substantial matter of arsenic after these trials, we must then conclude that the arsenic has been given in the form of a fluid; then there is, of course, the greatest necessity to analyze the stomach and its contents. We cut it into very small pieces, boil them in distilled water, with from one to four drachms of caustic potassa, strain the fluid through a white and clean cloth and filter it. Then we obtain a dark fluid, to which we have to apply small portions of nitric acid until the solution assumes a yellowish white color, which is to be neutralized with potassa, and then we shall be ready to apply the tests.

The analytical chemist has now two methods for ascertaining whether arsenic is in solution or not, these are—

1. The hydrochemical way, in which we use the reagents in a fluid state, and then compare the color of the precipitates produced by them with those of arsenic.

2. The pyrochemical way, which is by means of fire to reduce the arsenic to its metallic state. However, for a strict and correct inquiry, both these methods ought to be tried, because no hydrochemical test can serve before the court as an undeniable corpus delicti while the most characteristic indication, namely, the metallic lustre and the garlic smell of the arsenic, which is produced by the smallest quantity of that substance on burning coals can leave no possibility of doubt.

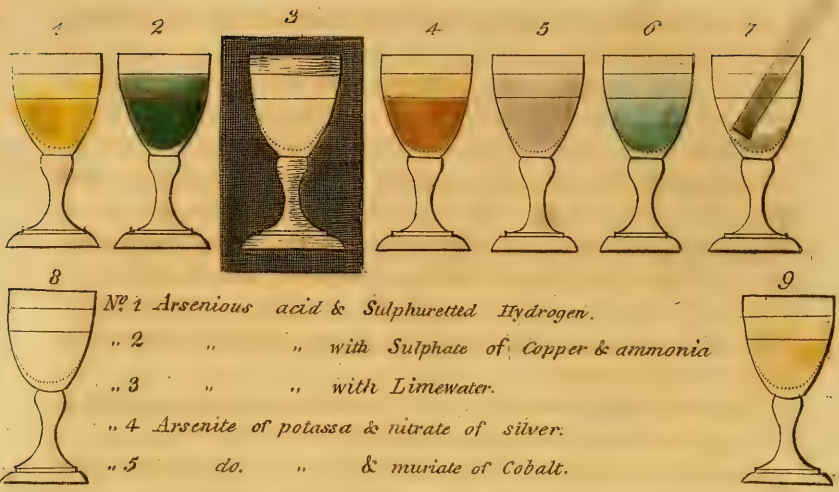
We proceed now to the hydrochemical tests, and it is, before all, necessary to prepare the precipitates of the tests out of the real arsenic as a standard by which to judge of the precipitates obtained by the fluid of the problematical arsenic.

Table I, exhibits the colors of the precipitates produced with *arsenious acid* by the following tests.

No. 1. The arsenious acid, in solution, brought into contact with sulphuretted hydrogen, forms a yellow precipitate of sulphuret of arsenic, or orpiment, which easily dissolves again in caustic potassa or ammonia. The precipitate of the sulphuret presents itself very soon, if we add some drops of muriatic or acetic acid.

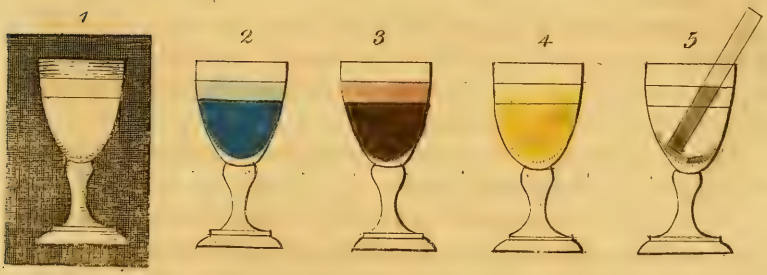
No. 2. Ammoniacal sulphate of copper, instantly produces in a solution of arsenious acid, a grass-green precipitate of arsenide of copper, or Scheel's green; but if the fluid contains too much acid, no precipitate is obtained.

Arsenious acid



No. 1 Arsenious acid & Sulphuretted Hydrogen.
" 2 " " with Sulphate of Copper & ammonia
" 3 " " with Limewater.
" 4 Arsenite of potassa & nitrate of silver.
" 5 do. " & muriate of Cobalt.
" 6 " " with muriate of Nickel.
" 7 " asidulated with sulphuric acid & touching a Zinc plate.
" 8 Arsenious acid & corrosive Sublimate with Limewater.
" 9 " " with Hydrosulphuret of Ammonia.

Arsenic acid



No. 1. Arsenic acid with Lime or barytic water.
" 2 " " with Sulphate of copper & ammonia.
" 3 Arseniate of potassa & nitrate of silver.
" 4 " " with sulphuretted hydrogen.
" 5 " " with Zinc plate.

If the precipitate dissolves in ammonia with a yellow color, the solution then contained no arsenious acid, but either a carbonate or a chromate of copper.

No. 3. *Lime, baryta or strontia* water, added to a solution of arsenious acid, produces a white, flocky precipitate, forming the arsenide of lime, baryta or strontia, which are soluble in acids and alkalies.

No. 4. *Nitrate of silver*, added to a solution of arsenious acid, neutralized with potassa or ammonia, gives a pale yellow precipitate, which, when exposed to the light, soon becomes grey, but this test acts only on the arsenides and not on the free acids.

The phosphoric acid and its salts are also decomposed by nitrate of silver.

No. 5. *Muriate of cobalt*, added to a neutralized solution of arsenious acid, shows a fine rose red precipitate.

No. 6. *Muriate of nickel*, applied to a neutralized solution of arsenious acid, gives an apple-green precipitate.

No. 7. *Arsenious acid*, when acidulated with some sulphuric acid and brought in contact with a zinc plate, presents the arsenic in its metallic state, at the negative pole.

No. 8. *Per-chloride of mercury*, (corrosive sublimate) mixed with arsenious acid, and then with some lime water, produces a *white* flocky precipitate, and not the orange yellow one, which we obtain from the combination of corrosive sublimate with limewater, known under the name of aqua phagedenica lutea.

No. 9. *Hydrosulphuret of ammonia* produces, with arsenious acid, a whitish yellow precipitate, in color, characteristically different from that with sulphuretted hydrogen.

Table II, shows the precipitates of the tests with *arsenic acid*, which, in comparison with arsenious acid, have almost all quite a different character.

No. 1. A colorless solution of arsenic acid brought into contact with *lime, strontia or baryta water*, produces a flocky white precipitate, which is soluble in an abundance of the acid.

No. 2. *Ammoniacal sulphate of copper* yields a sky blue precipitate.

No. 3. *Nitrate of silver*, added to a solution of arsenic acid, neutralized with potassa or ammonia, produces a brick yellow precipitate (but if the solution contains phosphoric acid, the precipitate is white.)

No. 4. *Sulphuretted hydrogen* after some time forms with arsenic acid, the yellow precipitate of sulphuret of arsenic.

No. 5. *Metallic zinc*, brought into contact with a solution of arsenic acid, precipitates the metallic arsenic at the negative pole.

Arsenic acid, added to a solution of corrosive sublimate, and then brought into contact with lime water, has not the least effect.

Muriate of nickel and cobalt are equally indifferent to arsenic acid.

After having now, with the prescribed hydrochemical tests, analyzed the fluid which we presume to contain arsenious or arsenic acid, we are not yet able to decide, with certainty, as to the presence of arsenic until we have pursued the analysis by the pyrochemical process, or have effected the reduction by heat, in the following manner. Both the precipitates obtained by lime water and sulphuretted hydrogen, and which have been laid aside in the former experiments, furnish materials, by the aid of which we may draw a correct conclusion as to the whole analysis.

The arsenide of lime is to be dried, mixed with boracic acid and charcoal, placed in a glass tube, and heated over a strong flame of a lamp or a small charcoal fire. In this process, the boracic acid forms borate of lime with the lime of the arsenide of lime, the oxygen of the arsenious or arsenic acid combines with the charcoal to form carbonic oxide and carbonic acid, and the arsenic sublimes in a metallic state and lines the walls of the tube.

The arsenide or arseniate of lime is also, according to Dr. Hare, treated with prussiate of Mercury (the cyanuret of mercury) in which case cyanogen, mercury, and arsenic are sublimed in gas and vapor, the first goes off in the form of gas, the second is condensed in brilliant globular forms on the walls of the tube, and the third is perceived by its peculiar smell and its appropriate metallic lustre, and the arsenic is therefore, characteristically enough, distinguished from the metallic mercury.

The sulphuret of arsenic, obtained by sulphuretted hydrogen, with arsenious or arsenic acid, is likewise to be dried and mixed with equal parts of carbonate of potassa, or caustic potassa and charcoal, and heated over the flame of a spirit lamp, where the sulphuret of arsenic is decomposed, and sulphuret of potassium is formed; the oxygen of the potassa combines with the carbon to form carbonic oxide and carbonic acid, and the arsenic, in the metallic state, is sublimed in the tube.

Dr. Hare, in his experiments, used lampblack moistened with a solution of caustic potassa. If now we have obtained from the reduction of the arsenide of lime and sulphuret of arsenic, the bril-

liant metallic ring, which is more characteristic than in any other substance, and the smell like that of garlic (by the volatilization of the metallic arsenic) which is still more remarkable and peculiar than its lustre; then we can, with certainty and a safe conscience, declare before the court and before God, that the individual who has perished by the use of such materials, has been poisoned by arsenic.

Remarks.—In the medico-juridical case, in June of last summer, in which I had the honor to assist Dr. Hare, in Philadelphia, we pursued the subject as above described, and succeeded perfectly. The use of the nitrate of silver, and ammoniated nitrate of silver, on that occasion being attended with some ambiguity, led me to further investigation, and I now conclude from a number of experiments which I have undertaken, though not with the poisoned contents of a body but with an arsenical solution, that phosphoric acid, which may easily be contained in the stomach and even remain in it after the treatment with nitric acid, is the only substance preventing the effect of the nitrate of silver.

MISCELLANIES.

(DOMESTIC AND FOREIGN.)

1. *The Author's Explanatory Notice of the* ELEMENTS OF CHEMISTRY, IN THE ORDER OF THE LECTURES GIVEN IN YALE COLLEGE.

THIS work, some time since announced through this Journal, is now nearly finished.

It is designed, as a companion to the lectures named in the title, which are given to the medical students, and to the senior and junior classes of the college;* usually about two hundred and fifty persons.

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* My attention was first called to the subject, by a vote of the classes of 1815, communicated by a joint committee, requesting me to furnish a guide, to accompany the lectures. I consented to make the attempt, and began to sketch and execute my plan; but, many circumstances, (with the statement of which, it is unnecessary to trouble the reader) conspired to impede and to stop my progress, until two or three years since, when the design was revived. The book was announced for one volume, and to be finished within a year; but, notwithstanding my unceasing efforts to condense the matter, and to complete the work, I have not been able to bring it, either as to time or extent, within the limits originally proposed.

The main object proposed is, to present the science of Chemistry, in an intelligible form, to those who are learning its elements. The attempt has been made, to unite copiousness with brevity and perspicuity; and to arrange the subordinate parts consistently with a general unity of design. That it may prove the more valuable and interesting, to those for whom it is written, the leading uses of the various substances are particularly mentioned; practical applications are interwoven with scientific principles, and many miscellaneous facts, not always indispensable to the text, are preserved in the notes.

The book was written, not to advance the knowledge of masters in the science, but to aid the progress of learners; and it is obvious that such an arrangement as might be most acceptable to the former, might be inexpedient for the latter, to whom at the outset, the whole is a *terra incognita.* None but those who have been concerned in teaching, can duly appreciate the difficulty of finding our way into the mind of the youthful pupil, and of fixing there the knowledge that we present to him. In the very commencement of his studies, he cannot be an adequate judge of our theoretical views, with regard to classification and arrangement; he may even fail to understand us, when we discuss them, and he will be most profited, and best satisfied, by that arrangement, which, in the most interesting and intelligible manner, presents to him the greatest amount of useful knowledge. In courses of instruction, and in books to accompany them, this object should, therefore, be paramount to every other.

With respect to arrangement, there are, however, certain points, in which most writers on Chemistry, and most teachers of the science agree. In general, the great powers that produce and influence chemical phenomena, namely, Heat, Light, Electricity, and Attraction, are first introduced; and their agency is illustrated through the whole chemical history of matter.

In arranging the simple bodies, all agree to place oxygen first, and the metals last. The remaining elementary bodies are usually employed to fill the hiatus which lies between them. They are the simple combustibles, and those agents, which, in chemical and electrical powers, are closely allied to oxygen, namely, chlorine, iodine and bromine.*

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* Fluorine is not mentioned, because its very existence is doubtful.

It is strictly logical, to place these three bodies and oxygen together, and of course, at the beginning; because, in the chemistry of particular bodies, we cannot move a step without oxygen; and happily, the illustration of its powers and general relations, is equally easy and delightful, both to the teacher and to his uninstructed pupil. But if, at this period, we proceed immediately to chlorine, iodine and bromine, both teacher and pupil are at once embarrassed, by properties and relations which the one cannot understand, and the other cannot explain.* Nor is there any sufficient advantage, to compensate for this embarrassment; for, we can dispense with the mention of either of these three bodies, and especially of the last two, until we are much further advanced, and have become rich in facts and principles, and expert in reasoning upon them. Then, after the combustibles, and before the metals, these other bodies may be introduced, with the happiest preparation; we easily and naturally revert, and explain their relation to the combustibles, and then we can also, with equal ease, illustrate their affinity to oxygen.

Thus far then, the course now sketched, would seem to be eligible;—that is to say, oxygen being placed first, and the simple non-metallic combustibles, next; the mutual relations of these furnish some of the most important acids; and when chlorine, iodine and bromine follow, and their relations are extended back to the preceding bodies, then several other acids, and compounds, of great interest and importance, are brought forward with advantage.

But, the greatest practical difficulty in making an arrangement, which shall be both intelligible and profitable to the pupil, still remains to be stated. The discovery of the metallic bases of the fixed alkalies and earths, by which it is proved that those bodies are oxides, leaves them to fall, by a natural method, into the train of the metals. If then, we sacrifice every thing else, to a method the most rigorously logical, we must break up the ancient and highly important classes of alkalies and earths; the account of them, as of isolated bodies, we must place, late in the course, or in the book, in the train of the met-

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* I am sensible, that writers of the greatest respectability pursue the course which is here objected to: in a work, intended for the learned in the science, or even for those who have a general knowledge of it, this is not of great consequence, because the anticipated relations are, in a greater or less degree, familiar. I would by no means be understood to censure such writers. My remarks have reference to works and courses of instruction, intended for pupils, to whom even the first elements are, as yet, unknown.

als, and in immediate sequence to their own metallic bases, which cannot be procured without previously obtaining, describing and decomposing the very alkalies and earths,* which are, immediately after, to be placed again in the rear of those metals, which have been extracted from them.

Nor, is this all. Ammonia, connected by every chemical and electrical affinity, with the other alkalies, and with the earths, is severed from them, and left behind, in an earlier part of the arrangement, in connexion with hydrogen and nitrogen, its parent gases, where it certainly belongs, and where most writers now place it. So far from objecting to this position of ammonia, I leave it there, and bring up the other alkalies and the earths into the same connexion.

In my judgment, the teacher, who postpones the history of the fixed alkalies and earths, until he can introduce them in connexion with the metals, subjects himself and his pupils, to much embarrassment; for, it is scarcely possible to proceed, more than a few steps, in the history of particular bodies, and in practical chemistry generally, without calling in the aid of the alkalies, and of some of the earths. It is true, that the fixed alkalies and the earths graduate, by almost insensible shades, into the other metallic oxides; but, the class of metallic oxides, (using the phrase in the most general sense) is so extensive, that there can be no logical impropriety, and there certainly is great advantage, in breaking it up into natural orders, of alkalies, earths and oxides, (proper) distinguished, as they are, by striking diversity of properties. It appears also very desirable to maintain, in the mind of the student, a clear apprehension of the distinct existence of alkalies, and of earths, and not to oblige him to look for them, one by one, among the subordinate compounds of metals. If studied in that manner, he will not see them grouped and described together, although they are connected by strong natural affinities. It is a very sensible remark of Dr. Ure—that, "Whatever may be the revolutions of chemical nomenclature, mankind will never cease to consider as earths, those solid bodies, composing the mineral strata, which are incombustible, colorless, not convertible into metals by all the ordinary methods of reduction, or when reduced by scientific refinements, possessing but an evanescent metallic existence, and,

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* This order, in the case of some of the common metals, creates no embarrassment.

which either alone, or at least when combined with carbonic acid, are insipid, and insoluble in water."

In teaching, it is highly important to avail ourselves of any knowledge which the student may be fairly presumed to possess: we thus proceed, from that which is more or less known, to that which is partly or wholly unknown; the student, to a degree, illuminates his own path, and he thus follows, with more cheerful confidence, the brighter light which his guide holds out before him. In the case in hand, enough is known in common life of the properties of alkalies and earths, to clear the first difficulties out of the teacher's way, and thus to render it easy for him to proceed with their history.

It appears therefore, highly expedient, not only that the alkalies and earths should be retained, as distinct orders of bodies, and be so exhibited to the pupil; but that they should also be introduced to his knowledge, as early as possible in the course of instruction; nor is there any serious logical inconsistency, or practical inconvenience in such a step. The metals of the alkalies and earths, if described immediately after their parent substances, will enable the teacher to complete the most important part of the history of all those bodies, without waiting for the distant period when the metals, as a class, will come to be described, each in its proper place; and when they do thus come, he will, of course, revert to the metals that have been already described; he will enumerate them in the catalogue of metallic bodies, and if any additional elucidations are necessary, he can then, by comparison and analogy, present them in the most successful manner, and their properties will, of course, be included in the preliminary account of metallic bodies.*

In the present state of chemical science, neither the analytical nor the synthetical method, can, in a course of instruction, be exclusively employed, with the greatest advantage. The synthetical is the most expeditious and convenient, and it prevails, more and more, as science becomes more extended, and acquires more certainty and precision: the analytical, although slower, is the most satisfactory, and the most interesting. Dr. Black taught principally in that manner;† Dr. Hope followed his steps; and Dr. Murray wrote his System, and his Elements, as far as practicable, upon that plan. Both courses may be

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* So many metallic bodies are familiarly known, that we do not anticipate in mentioning metals, at any period of a course of chemical instruction.

† As appears by his printed lectures.

and are pursued with advantage; both are necessary to render the account of a chemical compound complete, and the teacher or writer will, therefore, act his own judgment, as to the precedence which may be given to the one or to the other, when both modes are practicable. For example, the compound fluid, water, may be first described, as having certain physical and chemical properties: it may then be decomposed, say by the galvanic power, and its elementary gases obtained, distinct, or in mixture; those elements, after having been separately exhibited and described, may then be combined, by slow combustion, or by explosion, and the water reproduced;—thus, synthesis will follow analysis, and both modes united, give all the demonstration which the case admits of. The opposite order may, in this case, be pursued with perhaps equal advantage. This is a familiar example. It may be added, that in the history of the combustibles, and of the metals, it is usual to proceed synthetically, exhibiting the simple body first, and then its compounds; but, with respect to the metals which are the bases of the alkalies and earths, the opposite course appears to be the most eligible; the alkalies and earths being described first, we then proceed, analytically, to their decomposition, and return, synthetically, to their recomposition; and thus we arrive at the same result, which, in a different order, is usually pursued with respect to the other bodies.*

But, granting that the alkalies and earths are to be placed between oxygen and the metals, should they precede or follow the simple combustibles? In my courses of instruction, I formerly placed the combustibles first, and this order has much to recommend it; afterwards, following some of the earlier editions of Dr. Henry's Chemistry, (which was then, and for many years after, my text book,) I placed the alkalies and earths before the combustibles, and I am, on the whole, disposed to regard this order, as presenting fewer practical difficulties, in teaching, than the other; but it is not very important which is preferred. In Dr. Murray's Elements—(now in its sixth edition,) after oxygen, the atmosphere and water, are placed the combustibles; to them succeed chlorine, iodine and bromine; then follow the alkalies, and the earths and their bases, and thus we pass, by an agreeable and natural transition, to the entire class of metals. This arrangement is both logical and convenient; perhaps it is the best that can be devised.

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* In order to understand the metallic character of the bases of the alkalies and earths, no more knowledge of metals is necessary, than every one possesses.

The arrangement of THE ELEMENTS, *prepared for the classes in Yale College*, is as follows:

Volume I.

I. IMPONDERABLE AGENTS.

Under this division are included light, heat, and attraction,* and a general outline of galvanism.

II. PONDERABLE BODIES.

1. INORGANIC BODIES. Section 1. *Oxygen*, as a simple supporter† of combustion. Sec. 2. *Nitrogen*, and the atmosphere. Sec. 3. *Hydrogen* and water, and the oxy-hydrogen or compound blow-pipe. Then follow,

THE ALKALIES, in the order:

Sec. 1. *Ammonia.* 2. *Potassa.* 3. *Soda.* 4. *Lithia;*—with the metallic bases of the three latter.

THE EARTHS, in the order:

Sec. 1. *Lime.* 2. *Baryta.* 3. *Strontia.* 4. *Magnesia.* 5. *Silica.* 6. *Alumina.* 7. *Zirconia.* 8. *Glucina.* 9. *Yttria.* 10. *Thorina*, (added in an Appendix) with their respective bases, and a notice of Glass, after Silica; and of Porcelain, after Alumina. Next come,

THE SIMPLE INFLAMMABLES, in the order:

Sec. 1. *Hydrogen*, (as it was before described, it is only mentioned here, in its natural order.)

Sec. 2. *Sulphur*—its acids and salts; sulphurets, hydrosulphurets, &c.

Sec. 3. *Carbon*—carbonic acid, carbonates, carbonic oxide, carburetted hydrogen, &c.

Sec. 4. *Phosphorus*—its acids and salts; compounds, with combustibles and bases, &c.

Sec. 5. *Nitrogen*, (not a combustible in the popular sense, but sustaining relations to oxygen similar to those of combustible bodies) —acids of nitrogen, oxides, salts, &c.

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* We know not what attraction is; it is certainly an agent, and we cannot prove that it is material, much less ponderable; it stands therefore, correctly, under this head.

† Not supporters, as misprinted in the work.

Sec. 6. Boron, boracic acid, borates, &c.

Sec. 7. Fluoric acid* and its compounds.

Sec. 8. *Selenium*—its oxide, acids and salts.

Volume II.

Muriatic acid—muriates.

Chlorine—its oxides, chlorides, acid and salts, and compounds with combustibles.

Iodine—its acids and salts, and other compounds.

Bromine—its acids and salts, and other compounds.

The Metals, including the bases of the fixed alkalies and earths —their oxides, salts, and other compounds.

Organic Bodies.

I. *Vegetable matter.*

Elementary and proximate principles; spontaneous changes; fermentation; bread; alcohol; ether; germination; vegetation, &c.

II. *Animal matter.*

Its ultimate and proximate principles; decomposition; cyanogen; hydro-cyanic or prussic acid,† and the compounds of that class; animal acids; immediate parts of animals in connexion with the proximate principles that prevail in them.

Galvanism, (included in the beginning, in the list of general powers, and there concisely sketched as to its agency in attraction and repulsion,) is here exhibited in the necessary details, as it draws its illustrations from every part of Chemistry.

Tables.—Analysis of waters and minerals.—Addenda, &c.

It will be perceived, that the remarks already made on chemical method, render unnecessary any farther elucidations of the preceding arrangement. I will add, that Dr. Turner places oxygen at the beginning, but chlorine, iodine and bromine, follow the combustibles, and occupy the last place before the metals.

In a word then, the only important peculiarities in my arrangement are, that the alkalies and earths are introduced before the metals; and galvanism, although sketched in the beginning, is fin-

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* Placed here because it may have a peculiar combustible base.

† This is explained in a general way in the first volume, that we may be able to speak of its compounds with the metals.

ished at the close of the work. The preliminary outline of galvanism, given in the early part of the book, and preliminary and occasional experiments, made in the progress of the course, with a sufficient number of galvanic batteries, enable the student to understand the decomposing agency of this power, and the polar arrangement of the elements, as well as of the proximate principles; and, on this head, nothing more is needed, to enable him to proceed, intelligently, through the history of particular bodies. In the conclusion, therefore, the interesting topic of galvanism is, as it appears to me, best understood, in its more ample details and varied experimental illustrations. Should, however, any person use this work, who is of a different opinion from that of the author, either on this topic, or on that of the alkalies and earths, there is nothing to hinder his bringing in the whole of galvanism, before the history of particular bodies; and it will be equally optional with him, to study the alkalies and earths, either before or with the metals. When an entire work is in our hands, if our views do not correspond with those of the author, we can, with little inconvenience, dispose of its parts, in the order which we may prefer.

For my own convenience in teaching, and for that of my pupils in learning and in reciting, the matter of the Elements is divided under heads, distinguished by numerals, and under paragraphs, with letters prefixed; and capitals and italics are employed, to give prominence to the more important parts. In general, these parts are so constructed and arranged, that the reader may pass on, through the portions in capitals and in italics, and leave those in small roman, *without breaking the sense;* and thus a rapid review is easily taken, with the least expense of time. In most of the subjects, the principal heads, (usually in small capitals,) are—I. History or Discovery. II. Preparation or Process. III. Properties, physical and chemical; sometimes under two distinct heads. IV. Polarity or Composition; sometimes under subordinate heads. V. Uses. VI. Miscellaneous. Arabic numerals occasionally form a connexion between the greater heads and the smaller; and the latter are distinguished more rarely by large letters, but generally by small. The order and the number of divisions are, however, varied at pleasure, with the subjects. The great object in view, is to present all the subjects to the pupil, in the most tangible form; so divided, under proper heads and characters, that the thing wanted can be easily found; so condensed, that the facts and deductions may be included in as small a

compass as possible, consistently with their being intelligible; and yet embracing the most important things: copious references are also given to elementary and original writers, that the student may, if he can find the time and the books, prosecute the subjects farther. I have endeavored to avoid scattering the different members of a subject into separate parts of the volume, and have aimed as far as the previous statements in the work, or the actual state of general knowledge would permit, to keep entire subjects together.

Few authors, after incurring the great expense of time and money, and toiling through the severe labor, required by a difficult work, are either disposed or able to encounter the hazards of publication. The present, like most other works, has therefore, been consigned to the bookseller. Those, into whose hands it may pass, have a right to know the reasons that have determined the mode of arrangement and execution. This exposition, partially sketched in the plan, and at the heads of some of the sections, it was always my intention to give, more fully, when the work should be finished, and I am the moreover impelled to fulfill my design, by a respectful courtesy to those Colleges and Institutions which, after examining the first volume, have already placed my work in their printed list of classical books, or have communicated to me their intention so to do.

It is proper to add, that although I have been assisted in the revision, by several gentlemen, eminently qualified for the duty, and obligingly attentive to it, some errors and omissions have been discovered, since the sheets were printed. *I alone am responsible for them*, and as far as they have appeared important, or the necessary corrections were not very obvious, I have noted them in the errata or addenda. I pretend not, however, to have stated every fact and every opinion, for Chemistry has now become a vast Encyclopedia of knowledge. While selecting the materials, through so boundless a range, it is a matter of extreme difficulty to give even an outline, within moderate limits; and it is (as fully appears on a critical examination of the best elementary works,) still more difficult to avoid repetitions, necessary or casual, and to avoid also omissions, as well as errors in fact or opinion, and discrepancies in both; especially in a first edition of a work, demanding incessant vigilance, and an extensive examination and comparison of original and elementary writers.

Yale College, January 1, 1831.

2. *Proceedings of the Lyceum of Natural History of New York.*

(Continued from page 160.)

June, 1830.—A number of interesting minerals and fossils, American and foreign, were presented to the cabinet by Dr. Gale, Dr. Bibby, and the President; a collection of Austrian plants, by Baron Lederer; and by Professor Ravenel, of Charleston, S. C., a suite of shells from our southern coasts, among which were several rare species. The thirty-third Volume of the Memoirs of the Royal Academy of Turin, with other essays, were received from that institution, and from various members. Dr. L. Perez was elected a resident, and Mr. J. Barrabino, of New Orleans, a corresponding member.

July.—Mr. Irving, of the U. S. Navy, presented a number of volcanic and mineral productions, from various islands in the Pacific Ocean. Mr. J. Cozzens exhibited a recent specimen of that rare fish, the *Silurus marinus* of Mitchill's memoir on the fishes of New York, and communicated some verbal remarks upon it. Several new scientific works were received from European correspondents, and many valuable additions to the cabinet.

August.—Mr. Cooper made a verbal report on several shells of the family of Naiades, from Cumberland River, Tenn., received from Dr. Troost. Two species, supposed to be new, and peculiarly characterized, will be described by Mr. Lea, of Philadelphia, in a memoir which he is preparing on several new species of this family. Mr. Lea presented a collection of African and American shells, marine and fluviatile. Mr. Hayden, of Baltimore, and Messrs. Cozzens and Richards, presented geological and mineral specimens, from various parts of the United States.

Dr. Feuchtwanger communicated a paper, wherein he arranges several analyzed minerals according to the electro-chemical system of Berzelius. Mr. Cooper exhibited No. 84 of the "Recueil de Planches Coloriées" of Temminck, in which this ornithologist has described and figured, (Pl. 495) the *Falco atricapillus* of Wilson, as an entirely new species, under the name of *Falco regalis*. His reason for this seems to be, that Cuvier has given the name of *atricapillus* to another species of the same genus. But this was not until several years after the publication of Wilson's Ornithology, whose appellation must therefore be retained for our bird, which now seems

to be admitted as a distinct species from the *F. palumbarius* of the old continent.

The President offered, in the name of Mr. Mead, a donation of a suite of select specimens of English fossils. The Transactions of the Physical Class of the Asiatic Society of Bengal; the conclusion of the third, and commencement of the fourth volume of the great work on the Mammalia, by F. Cuvier and St. Hilaire, and other works, were received this month, the first from the Asiatic Society. Mr. A. Thompson was elected a resident member.

September.—Dr. Graves presented minerals and fossils from Cuba; and the Rev. Mr. Robertson, minerals and shells from Greece and the Levant. Dr. Feuchtwanger read a paper, describing the new mineral called Aëschynite. Dr. Torrey read a letter from Dr. Eights, containing a sketch of his observations during his recent voyage to the South Seas.

Mr. Halsey communicated some observations on the habits of an insect which attacks the honey locust (*Gleditschia*) in this vicinity, the branches of which it completely girdles, but for what purpose is unknown. Mr. Halsey considers it closely allied to, if not the same with the *Lamia amputator* of St. Vincent's, described by Mr. Guilding in the Linnean Transactions. Dr. Eights presented crustaceous animals, found in a Cod, taken off Cape Horn, and bearing much resemblance to the Trilobites. Several presents of insects, books and minerals were laid on the table.

October.—Dr. Torrey read a paper on a new and very tall species of Euphorbia from Pennsylvania, which he proposes to call E. Darlingtoniana, in honor of the discoverer. Dr. T. also communicated a description of a new species of Campanula, from New Orleans, *C. ludoviciana.* The President gave a verbal account of certain remarkable sutures which he has recently observed in the gneiss rocks of this island. They are about a foot long, deep, parallel, and cross the strata at right angles, differing entirely from the superficial grooves already noticed, and such as cannot be accounted for on the supposition of abrasion from bowlders. Mr. Cooper read a notice of several North American birds, that appear to have changed or extended their habitation within late years.* Many interesting addi-

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* One of these is the Cliff Swallow, of which an interesting notice is given by Mr. Woodruff, in the last No. of the Am. Journal of Science, p. 172. See Bonaparte's Am. Orn. Vol. I.

tions to the Cabinet and Library were received. Dr. Feuchtwanger was elected a resident member.

November.—Capt. Delafield, of the U. S. Engineers, presented fossil crabs and shells from the dry dock excavation, Gosport, Va.; and Mr. G. Gibbs, of Turks Island, a collection of choice specimens of Echini and other radiary animals, together with zoophytes and shells from the Bahamas.

Information was received through the President, that Dr. Thomson, of Glasgow, has continued his analyses of American minerals, of which a part have already appeared in the Annals of the Lyceum. Prof. T. announces that the radiated tremolite of Corlaer's Hook is hydrous *Anthophyllite;* the Scapolite of Bytown, Canada, is a variety of pyroxene, which he calls *Alalite;* and he gives the name of *Perthite* to a new mineral from Perth in Upper Canada.

3. *Academy of Natural Sciences of Philadelphia.*—Since the notice of this institution in our last number, its collections have received some munificent additions. The first of these is from Dr. Burrough of Philadelphia. This gentleman has recently returned from a voyage round the world, in the progress of which he visited some of its most interesting regions. The scientific zeal and industry evinced by him on these occasions have few examples on record. South America, India, and the intervening ocean, were all laid under contribution, and he has returned to his native country, freighted with the treasures of nature. Among these are extensive collections of birds, quadrupeds and shells, together with smaller ones of the subordinate classes of animals. Some of these productions have never before reached this hemisphere, among which we may mention, as a prominent object, the Thibet ox, one of the rarest of its kind. Dr. B. also obtained, by unwearied personal exertion, the complete skeleton of an adult Rhinoceros.

This varied series of organized beings, has been deposited with a munificent liberality, in the Academy of Natural Sciences, in which no expense or labor will be spared, to have them arranged and displayed in a manner equally consonant with elegance and usefulness.

In addition to the former splendid collection of birds, plants, &c. received from Dr. Hering of Surinam, the Academy has more recently to thank that indefatigable naturalist, for some valuable additions to their cabinet. These consist of a very extensive series of

the quadrupeds, fishes, and reptiles of the Province of Guayana. The number of species is not less than five hundred, and the admirable preservation in which these objects have arrived, is matter of congratulation and surprise. We have much pleasure in adding, that the liberality of Dr. Hering to the Academy has been suggested and directed by the Rev. Lewis De Schweinitz, of Bethlehem, Penns. The collections in question were submitted to the discretional distribution of the latter gentleman, who immediately transmitted them entire to the Academy of Natural Sciences.

4. *Swallows.*—Dr. Steel states that he had not had opportunity, and I have not had leisure, to compare the facts stated by him with the description of this bird in the Ornithology of Bonaparte.*—*Ed.*

Extract of a letter from Dr. J. W. Steel, of Saratoga Springs, to the Editor, dated Dec. 9, 1830.

After adverting to the notice of Mr. Samuel Woodruff, in the last No. of this Journal, page 172, and to a similar notice, published some years since, by Mr. George Clinton, Dr. Steel adds the following facts, the amount of which is condensed from his letter.

"In 1800, I first noticed a colony of these birds at Union, in Maine: their nests were constructed of mud, and occupied the entire front of a long barn, filling the space under the eaves. Some intelligent persons at the place, stated that the nests were made by the Bank Swallow or Sand Martin, (Hirundo riparia) whose mode of excavating their dwellings in high banks of sand, is well known: in the present instance, the bird, finding no suitable spot in that, then new settlement, to construct its usual habitation, (there being no sand banks in that part of the country,) it had recourse to the expedient of constructing an artificial bank for its immediate accommodation, thus indicating a degree of ingenuity, but imperfectly expressed by the usual word *instinct.*

Five years ago, in Greenfield, eight miles north of Saratoga Springs, I discovered some similar nests, beneath the eaves of a small barn, and saw the birds busy in repairing their old habitations, and in constructing new ones, and I was soon convinced that they

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* See note on page 354.

were not of the same species as the Sand Martin. The owner of the barn stated, that they were first seen there early in the preceding season, that they then constructed but two nests, in each of which they reared a brood, and retired about the same time that Swallows and Martins usually disappear; that they had returned that spring in additional numbers, and about a dozen were then employed in preparing their nests. They had then been seen in no other place in that vicinity. I learn that their numbers are now over fifty, and that they have occupied the same station ever since.

Early in the summer of 1829, I saw a new colony of the same species of birds at Caldwell, head of Lake George; they had attached their nests, in great numbers, to the timbers under the roof of an open tavern horse shed; and they did not appear disconcerted by the teamsters, within reach of whose whips they were industriously building and repairing their nests, in a place, which they had occupied exclusively for two successive years.*

During the late summer, (1830) I found still another family of these winged emigrants; they were established under the eaves of a large new barn, in Saratoga, eight miles east from the Springs: they arrived, in small numbers, in the spring of 1828, and occupied both sides of the barn; they have since increased rapidly, and they were computed, the season past, at some hundreds.

5. *Annals of education and instruction; conducted by William C. Woodbridge, assisted by several friends of education, united with the American Journal of Education.*—"During a residence of several years abroad, the editor of the work recently proposed under the above title, had collected many important facts on the subject of education from personal observation, and from intercourse with some of the most distinguished educators of Europe, among whom were Pestallozzi and Fellenberg. At a period, so remarkable for the efforts made to improve our schools, he felt it his duty to present the information he had obtained, to those whose circumstances and talents render them more capable of applying it than himself. He found reason to believe, that no medium of communication would be so efficient for

* The landlord was unwilling to favor me with a pair of the birds.

this purpose as the periodical press; and he therefore resolved to establish a periodical work, devoted to the subject of education.

In order to avoid the evils resulting from the existence of two similar publications, it was thought best to unite the above work with the American Journal of Education. The property of this Journal has therefore been transferred to Mr. Woodbridge, who is favorably known to the public through his systems of Geography, and the work will hereafter appear under the title of *Annals of Education and Instruction, and American Journal of Lyceums and Literary Institutions.*

In its progress, it will contain a detailed account of the Institutions of Fellenberg, derived from actual observation, and from manuscripts communicated by the founder, the introduction to which was published in a late number of the American Journal—a description of other similar institutions—of schools on the plan of Pestallozzi—of seminaries for teachers—and of recent improvements in instruction in Germany and France—together with intelligence concerning the state of schools, Gymnasiums and Lyceums in our own country and occasional essays of a speculative and experimental kind. In the latter departments, the editor has received assurance of aid from gentlemen who enjoy the confidence of the public, and whose rich experience and important views on the subject of education, he has endeavored thus to elicit for the benefit of our numerous rising seminaries."

From a long personal knowledge of Mr. Woodbridge, we have full confidence in his talents and resources, and in his zeal in this good cause; we wish him and his coadjutors full success.—*Ed.*

6. *Mastodon, near Rochester, N. Y.*

Extract from a letter from Mr. J. A. Guernsey, to the Editor, dated Pittsford, October 26, 1830.

I have just procured a piece of a tusk found three weeks since in the bank of the Ironduquoit Creek, two and a half miles from this place; a boy struck a spade against the point of the tusk and broke it off, he then dug parallel to the surface of the earth, about five feet below the sod, but he broke it into five pieces. The entire length of all the pieces was seven and a half feet, and the whole tusk must have measured nine feet. The exposure to the air causing it to

slack and crumble, I advised the possessor to lay it in a box of sand where it now remains.

The root or butt of the tusk is hollow for eighteen inches. The longest piece measures twenty two inches in length, and sixteen and a half inches in circumference, weighing twenty two pounds. The weight of the whole was, when I first saw it, fifty seven pounds and eight ounces.

The above sketch is from memory.

P. S. One of the vertebræ of the neck was also found, weighing two pounds two ounces; it was apparently very much decayed. The owner of the land intends digging for the remainder of the skeleton.

7. *Analysis of the supposed Anthophyllite of New York, in a letter from Thos. Thomson, M.D. F.R.S. Professor of Chemistry, Glasgow, to A. F. Holmes, M.D. M.W.S. Lecturer on Chemistry, McGill College, Montreal.*—I have submitted to analysis the specimen which you marked Anthophyllite from New York. From the peculiarity of its appearance, I could not be sure whether it was anthophyllite or not. The result of the analysis was as follows.: specific gravity 2.911.

Constituents.		Atoms.
Silica,	54.980	51.
Magnesia,	13.376	10.
Protoxide of iron,	8.849	4.15
do. of manganese,	1.200	
Potash,	6.804	2.09
Alumina,	1.560	1.28
Water	11.448	19.
	98.217	

This comes very near $5MS^3+2fS^3+kS^3+0.64AlS^2+9\frac{1}{2}Aq$. If we omit the ter-silicate of alumina, as not amounting to an atomic quantity, the formula gives $5MS^3+2fS^3+kS^3+9\frac{1}{2}Aq$.

I analysed a very poor specimen of anthophyllite, some years ago. The constituents were as follows: specific gravity 3.1558.

		Atoms.
Silica,	56.290	28.14 or 35.8
Magnesia,	19.665	7.86 " 10.
Protoxide of iron	7.280	1.61 " 2.04
Potash,	13.500	2.25 " 2.86
Alumina,	1.545	0.68 " 0.86
Water,	1.685	1.5 " 1.9
	99.965	

You perceive that in true anthophyllite, if the magnesia be considered the same, the protoxide of iron is only one half what is in your specimen; the potash is about one fourth more, and the water is only one tenth of the quantity in your mineral. The formula for anthophyllite is $10MS^3+3KS+2fS^2$.

The two minerals are therefore not the same. Perhaps your specimen may be called hydrous anthophyllite; but it must be reckoned a new species.

Note.—The mineral analysed by Dr. Thomson, and ascertained to be a new species, is, I believe, rather abundant near New York, and formerly went under the name of radiated actynolite and asbestus, but was subsequently, from comparison with European specimens, supposed to be anthophyllite. A. F. H.

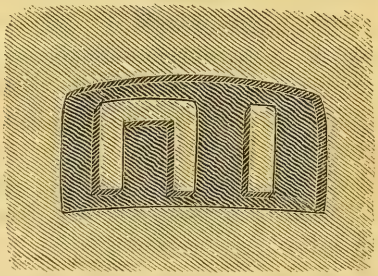
8. *Penetrativeness of fluids.*—The memoir of Dr. J. K. Mitchell on this subject, published in the Am. Jour. of Med. Sci. of Philadelphia, for November, is replete with interesting facts and deductions, and deserves a distinct analysis, which neither our time or limits will permit us to give.

9. *Albany Institute.*—The transactions for October and November have been published; the former contain a discourse delivered on its first anniversary, April 23d, 1830, by Benj. F. Butler. The latter, a notice of the graphite of Ticonderoga; a piece on the apparent radiation of cold, by Prof. B. F. Joslin, and another, containing the elements of the solar eclipse of Feb. 12, 1831.

10. *Singular impression in marble.*

TO PROF. B. SILLIMAN.

Dear Sir—About twelve miles N. W. of this city, is a marble quarry owned by Mr. Henderson. It belongs to the primitive lime formation, and in this district forms the last of that series. The order in which the rocks repose are, commencing at Philadelphia, as follows; gneiss, mica slate, hornblende, talcose slate, primitive clay slate, a very narrow strip of eurite, and then the primitive lime rock, to which this belongs. The quarry has been worked for many years, in some places to the depths of sixty, seventy, and eighty feet. In the month of November last, a block of marble measuring upwards of thirty cubic feet, was taken out from the depth of between sixty and seventy feet, and sent to Mr. Savage's marble saw mill in Norristown to be cut into slabs. One was taken off about three feet wide and about six feet long, and in the body of the marble, exposed by the cutting, was immediately discovered an indentation, about one and a half inches long and about five eights of an inch wide, in which were the two raised characters. Fortunately, several of the most respectable gentlemen residing in Norristown were called upon to witness this remarkable phenomenon, without whose testimony it might have been difficult, if not impossible, to have satisfied the public, that an imposition had not been practised by cutting the indentation and carving the letters after the slab was cut off.



I send you a cast of the impressions by the bearer of this letter. I am Sir very sincerely, your obt. servt. J. B. Browne.

Philadelphia, April 1st, 1830.

An apology is due for the delay in publishing this notice, which was mislaid by accident.—*Ed.*

11. *Remarks on the amelioration of our physical climate; by David Thomas.*—Among the visions of Philosophy in the last age, none has been more pleasing than the notion that with the destruction of our forests, the rigors of winter will abate; and that Hesperian fruits and flowers without protection, will soon decorate and enrich these northern regions.

It seems surprising that those theorists should permit a few isolated facts from history, and a few random assertions from poetry, to engross their attention, to the total neglect of every surrounding circumstance.

Let us consider what happens in our forests. The fallen leaves prevent the soil from freezing in winter;* the trees obstruct the radiation of heat in clear nights; the snow settles evenly through the woods; the cold winds are unable to throw it into drifts, and the warm winds to melt it until the commencement of spring. Many a green-house plant would abide the winter with such protection.

But with the removal of the forest, this shelter is withdrawn, and the ground *then* freezes to the depth of several inches.

If it be alledged that the warm winds have more access, so have the cold winds. If the sun shines clearly on the open plain, it gives more heat amid the reflection and shelter of leafless trees; and it is well known that fields surrounded by woods, produce earlier pasture than the open plains.†

But by what agent can a cultivated country disarm the wintry tempest of its rigor, when the mercury sinks below zero? How can it soften those freezing winds which overwhelm it for days together? On the vast surface of our inland seas, and on the wide spreading prairies of the West, how can cultivation affect the physical climate?—for there are no forests to be destroyed.

In *the open country* of the Mandans—not as far north as the city of Paris—Lewis and Clark found the thermometer 43° below zero. At the falls of St. Mary's *near Lake Superior*, Dr. Foot found it 30° below zero "on the 6th of February;" and in the mornings of *the two last days of that month*, it stood 24° below zero.

We are near to regions that endure a polar winter; we are within the reach of their frozen atmosphere; and we can hope for a milder climate only when the north winds shall be retained.

12. *The Chemistry of the Arts; being a practical display of the arts and manufactures which depend on chemical principles. With numerous engravings. On the basis of Gray's Operative Chemist, adapted to the United States, with treatises on calico printing, bleach-*

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* In this northern part of the 43d degree of latitude.

† It may be less known that some vernal flowers bloom finely in the woods, while the same kinds are despoiled of their beauty by frosts in the open garden.

ing, and other large additions, by ARTHUR L. PORTER, *late Professor in the University of Vermont.* Philadelphia: Carey & Lea, 1830.

This is a thick octavo volume of eight hundred pages, containing a description of those arts which depend upon chemistry; with plates representing buildings, furnaces, machinery, utensils, and containing directions for performing the various operations.

Gray's Operative Chemist was published in London, so late as 1828. Mr. Gray was himself an able, *operative chemist*, and conversant with most of the subjects of which he treated: at the same time he enjoyed every facility afforded by the metropolis, and an "extensive intercouse with scientific and practical men," which enabled him to furnish a systematic treatise, comprising what was valuable in a chemical dictionary, with the vast improvements made in the arts by the discoveries of modern science.

Professor Porter's object has been, not only to adapt the work to the use of American manufacturers, but to make it of the greatest practical utility for the work shop. For this purpose, he has omitted such processes as are not likely to be useful in this country, and such parts as relate to the theoretical principles or philosophy of chemistry. He has made several additions, which are the results of his own observation. They relate principally to the manufacture of oil of vitriol and bleaching powder, calico printing and bleaching. Each subject is exhibited in a manner so concise, as to consume but little of the artizan's time, and yet so clear as to be intelligible to the general reader.

The work, though purely practical in its design, contains such varied and extensive information, relative to the origin of materials and the operations connected with the different arts, as will not only render it valuable to the mechanic, but highly interesting to the curious.

13. *A Treatise on Fever, by* SOUTHWOOD SMITH, M. D., *Physician to the London Fever Hospital.* Carey & Lea, Philadelphia.—An American edition of the work expressed by the above title, has just been published by Carey & Lea, of Philadelphia. Dr. Smith has treated the subject of fever, that most important branch of physical science, in a lucid and highly interesting manner. This theory, which is very perspicuous, appears to be sanctioned by a close and discriminating observation of symptoms, through a series of years in hospital practice, and a faithful examination after death.

Dr. Smith considers a specific poison applied to the brain and nerves as the exciting cause of fever, and that this poison emanates from vegetable and *animal* substances, which at certain stages of decomposition, send forth miasmatic effluvia, destructive to life. In the present state of knowledge, the form of this poison is wholly unknown, but that it is a material entity, of most deadly agency, is proved by undeniable evidence. This is an important step gained, since it may teach us the means of preventing its developement in many instances, and of shunning the danger of it in those regions where the industry of man cannot overcome or prevent it. Dr. S. considers all the forms of fever as identical, and says, "the condition of the organs is found to be absolutely the same in every variety, never differing in any thing but intensity." Although the inferences he derives from the pathology of fever lead to a mode of treatment the reverse of that practised by some other physicians of eminence, he is particularly careful to state, that he urges this practice upon those only who are under similar influences of climate and habits, and under certain modifications of the disorder. He must be an acute naturalist and philosopher, who can detect the agencies which disturb the secret influences of the brain, and cut off the supplies of activity and vigor dispensed by the nerves to the organs of respiration and life. The mysteries which still involve the subject invite the aid of science to further investigation. Although so much has been done in discovering which are the organs primarily affected by the poison of malaria; and although the progress of its operation has been traced with surprising clearness by Dr. Smith, from the brain and nerves to the circulating system, and thence to the respiratory organs and the digestive apparatus; disclosing many important facts that indicate the probable efficacy of remedies; yet he acknowledges that "many are the dark spots which remain in this part of the field of knowledge, and that many laborers must work long and skillfully before they will be removed." What is the morbid state of the brain and nerves, which causes such frightful consequences to the whole frame, remains unknown. Whether it is owing to debility of those organs, by which they fail to impart the spring of life to the respiratory and circulating systems—or whether to a species of inflammation peculiar to the nervous structure—or whether it is an effect like that produced by narcotic poisons—or whether some affection pervades their substance of which no analogy is furnished by physiology—remains a subject of the deepest interest to the medical and philosophical inquirer.

If minor praise may be allowed on a subject so grave, it may be added that the work is written with a spirit and elegance, which could scarcely have been thought compatible with details of some of the most revolting and appalling sufferings which afflict the human race.

14. *Pathological and Practical Researches on Diseases of the Stomach, the Intestinal Canal, the Liver, and other viscera of the Abdomen.* By John Abercrombie, M. D. *Fellow of the Royal College of Physicians of Edinburgh, &c. and first physician to his Majesty in Scotland.* Carey & Lea, Philadelphia, 1830.

15. *Elements of General Anatomy, or, a description of every kind of organs composing the human body, by* P. A. Beclard, *Professor of Anatomy of the Faculty of Medicine of Paris. Preceded by a critical and biographical memoir of the author,* by Olivier, M. D. *Translated from the French, with notes, by* Joseph Togno, M. D. *Member of the Philadelphia Medical Society.* Carey & Lea, Philadelphia.

FOREIGN.

1. *M. A. G. Labarraque's method of using the chloride of soda, translated from the French, by Dr. Jacob Porter.*—From the numerous applications made by the most distinguished physicians, and followed by uniform success, it results that the chloride of soda should be used in the following manner:

For ill-conditioned ulcers let a glass of the chlorated liquor be mixed with five times its quantity of pure water, and in this mixture dip the lint, with which the ulcers are to be dressed. The dressings should be applied twice a day. If the sore becomes red and inflamed, this mixture should be still further diluted; if, on the contrary, the sore does not change its appearance, it should be dressed once or twice with some chloride diluted with only half its quantity of water, so as to bring on a slight inflammation, which is indispensable for causing atonic ulcers to pass to the state of simple sores. The healing will then go on rapidly. At the time when the chloride is applied to the ulcer, the fetid smell is destroyed.

Gangrene, hospital putrefaction, ill-conditioned burns and scalds, old ulcers, corroding herpetic affections, and the like should be treated in the same manner.

Cancer in a state of suppuration may be disinfected with some lukewarm or cold water, containing a twentieth of the chloride of soda. The same mixture, or weakened still more with from five to ten parts of water, should be used for internal ulcer; the injections should be made two or three times a day. Boiling water should first be passed through the syringe, and this liquid be immediately replaced by the chlorated water; the heat of the metal will be communicated to the chlorated water, the temperature of which will be sufficiently raised to answer for the injection.

For ulcerations of the nasal organs, the throat, the palate and the gums, the chloride should be diluted with from eight to ten parts of water; it will, nevertheless, be necessary to touch these sores with a little lint moistened in some pure chloride.

For the scald head the chloride should be mixed with only an equal quantity of pure water, and the parts affected be moistened with this liquid twice a day.

The lint and cloths, that have been used in dressing fetid ulcers, instantly lose their smell on being dipped into water containing a thirtieth of the chloride.

Great advantages have been obtained from using the chloride very much diluted in water, for all the purposes of the toilet. In a dose of from twenty to twenty-five drops, it acts as a bracing and preserving wash, prevents the spread of herpetic eruptions, and cures certain diseases of the skin.

For carbuncle the chloride of soda should be applied pure; but, in this case, it will be necessary to have recourse to a physician, who will precede the use of this medicine with the means required by the rules of surgery. In order to determine the real nature of the sores, it will be prudent likewise to recur to his experience.

Every person affected with a severe disease, or with sores of a bad character, vitiates the air of the chamber where he is confined, both patient and attendants suffering from the unwholesome taints. This air may be purified by mixing a spoonful of the chloride with six spoonsful of water in a plate, and setting it under the patient's bed: indeed, several plates of the diluted chloride may be placed in the same apartment, if necessary. In this way, the exhalations will be destroyed as soon as they are produced. It will be necessary to renew daily the chlorated water contained in the plates, and turn it into the vessels where the cloths, that are used for the dressings, are soaked.

Whenever it is necessary to attend patients affected with contagious diseases, such as small pox and the like, it will be found very beneficial to wash the hands with water containing a twentieth of the chloride, and apply to the nose a bottle containing some of it in a concentrated state. After handling the sick, it will be proper to wash again with the chlorated water.

In all places where there is a crowd of men or animals, whether sick or healthy, the air becomes corrupted, and acquires deleterious properties, owing principally to the animal exhalations. These exhalations may be destroyed by sprinkling the chloride diluted in from twenty-five to thirty parts of water; or by setting in these places, (and they may be out of sight,) some vessels containing the chlorated water, which can never be in the least injurious, whatever may be the quantity. This method of purifying the air is indispensably necessary in lazarettos, hospitals, prisons, poor houses, manufactories, churches, seminaries, convents, halls of study, and dormitories in colleges and boarding houses, cabins of ships, court rooms, crowded theatres, saloons when filled to excess on great occasions, and the like.

Sprinklings of the chlorated water will be more especially necessary whenever an epidemic or contagious disease prevails; they should be made in order to guard against the deleterious influence arising from the neighborhood of marshes, the rotting of flax, hemp and the like. They will likewise be serviceable in the disease of domestic animals, in places where silk-worms are raised; finally, in all places where the air becomes charged with exhalations, which, on being accumulated, produce fatal effects.

In cases of asphyxia, produced by the exhalations of vaults, sewers or any considerable masses of putrefying animal substances, it will be necessary for the patient to breath the concentrated chloride; and his chamber should be sprinkled with the chlorated water, so as to subject him to the influence of the disinfecting agent.

It is often necessary, sometimes from a tender and pious feeling of regret, to preserve for a long time the bodies of deceased persons. A fetid odor appears more or less readily, according to the temperature of the air, the state of the patient's body at the time of his decease, or the disease that terminated his life. This decomposition may be suddenly arrested; indeed, it may be prevented by sprinkling the body with some chloride of soda diluted in water. For this purpose, a bottle of chloride should be mixed with twelve liters or bottles of water; a linen cloth should be wet in this mixture, laid on

the body, and sprinkled occasionally with the liquid. In this way, a corpse may be preserved indefinitely by a process, which will be made known elsewhere.

By sprinklings of water containing a fortieth of the chloride, one may disinfect, in a moment, the filthiest kennels, sewers and drains, vaults, slaughter houses, markets for meat and for fish, manufactories for glue and for cat-gut, and, generally, all places, that are infected with animal exhalations.

Butchers' stalls should be sprinkled, in the hot season, with the chlorated water, and, by this means, the meat will be preserved for a long time unaltered.

In butteries, especially in the country, where it is often necessary to lay in provisions for a week, the meat may be preserved, if care is taken to set on the floor a vessel containing some of the chlorated water, which it will be necessary to renew daily. If the meat has become fetid, a simple immersion in water containing a fortieth of the chloride, will neutralize the smell, and, after being washed in pure water, it may be cooked and eaten without injury to the health.

Notes.

1. Persons affected with the nervous asthma breathe more freely in apartments that contain the chlorated water; and it has been observed that attacks of this disease are less frequent with such as take care to keep in their sleeping rooms, during the night, vessels of the chloride diluted in eight parts of water.

2. The Council of Health of the lazaretto of Marseilles resolved, in December, 1825, that the chlorides should be substituted for fumigations in the lazarettos, for purifying passengers and their baggage, also patients attacked with the plague, and other suspected persons, as well as for the daily cleansing of ships at quarantine. In May and August, 1826, the quarantine physician and health officers, who attended the patients attacked with the sea typhus, were preserved from the disease, simply by the use of the chlorides; while, in 1818, in the same place and under the same circumstances, the typhus was communicated to the health officers and quarantine physician, notwithstanding the daily use of the Guiton fumigations.

3. Official reports, sent to the French government by the consul general of the king at Aleppo, who was provided with some bottles of the chlorides, certify, that by the use of them, a great number of persons were preserved from the plague during that dreadful epidemic, which cost Aleppo no less than twenty-five thousand lives in

the space of four months. His excellency, the minister of the interior, has had the kindness to transmit me, by his letter of December 31, 1827, a copy of these valuable documents, which I shall consign to the pages of my next publication.

4. By immersion in chlorated water anatomical pieces can be preserved for a long time in very hot climates.

Remark.

It may, perhaps, appear surprising that I attribute so many properties to the chloride; but they have all been substantiated by facts, and it is on the authority of these facts that I publish these instructions, for the sole purpose of preventing the evils, that might result from an unskilful use of it. I hope soon to lay before the public a number of other uses, not less important than those I have already published, and thus to justify the honorable suffrage of the Society for the Encouragement of National Industry, which, at its general sitting of October 30, 1822, decreed me a prize, which was followed by a resolve of the counsellor of state, prefect of police, under date of October 19, 1823, directing the establishment of my process of disinfection at la Morgue,* and with the police agents of the metropolis.

I hope likewise to justify the no less honorable testimony of the Royal Institute of France, which awarded me a prize of three thousand francs at its public sitting of June 20, 1825. Adopting the instructions of this illustrious body, the minister of the interior, by his circular to all the prefects, dated October 17, 1825, was pleased to direct the use of the chlorides as disinfecting agents, and as means of cleansing the lazarettos, prisons and other unhealthy places. The counsellor of state, director general of the public works at Paris, has likewise ordered the use of the same disinfecting agents in the numerous establishments subject to his direction. The authentic results, when obtained, will be presented to the public.

2. *Seleniuret of palladium, &c.*—We are requested by Dr. Lewis Feuchtwanger to state, that the mineral described by him as the seleniuret of lead, consists principally of palladium, and is now called in Europe seleniuret of palladium, silver and lead.

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* The place in Paris where the bodies of suicides and others found dead, are deposited for inspection, that they may be claimed by their friends.

Notices Translated and Extracted by Prof. J. Griscom.

CHEMISTRY.

1. *Salicine.*—Dr. Julius Guerin communicated to the French Academy, on the 12th of April, a letter on the discovery of Salicine, a substance extracted from the bark of the Willow, (Salix alba). When M. Leroux, pharmacien at Vitry le-Francais, informed the Academy of the discovery he had made of Salicine, some persons claimed the honor of it for *M. Buchner*, a German Chemist. The memoir of this gentleman which is just published in the Journal of Pharmacy, proves most clearly, that the two substances are not the same; and that there is as much difference between the salicine of Buchner and that of Leroux, as between the extract of quinquine, and quinine. Salicine has been employed with much success at La Charité, in the cure of intermittent fevers.—*Rev. Encyc.* A similar, but not identical notice, was inserted in our last.—*Ed.*

2. *Milk Tree.*—M. Delessert communicated two letters which he had received from Scotland. The first, relative to a new tree which furnishes milk fit to drink. Humboldt had discovered in the province of Venzuela this curious tree, called the Cow Tree, (*palo de Vaca,*) which is of the family of the Urticæ, and which furnishes a very good milk. Since that time, Mr. Lockhart, conductor of the Botanic garden of La Trinité, has discovered several individuals of them in the province of Carraccas, the milk of which is used by the inhabitants. He has sent several specimens to Europe. Mr. James Smith has recently found on the borders of the River Demerary, a tree, called hya-hya by the natives, which furnishes a very rich milk, thicker than that of the Cow, free from bitterness, and but slightly viscid.

The second letter of Mr. Delessert is relative to the germination of the diœcious plant, long known by the name of Nepenthes, and remarkable for the urns which placed at the extremities of its leaves, become filled with drinkable water, and then close by an operculum. A female plant having been brought into contact with a male individual at Edinburgh, mature grains were obtained, which being sown, furnished several small plants. Dr. Wallich, director of the garden at Calcutta, has sent M. Delessert a new species of this plant, whose urns are spherical. The East India Company has placed at the disposal of Dr. Wallich the beautiful and numerous collections, obtained at great expense by the botanists whom they had sent throughout India, and the neighboring countries, and has charged this gentleman to furnish duplicates to the Botanists of France, and other countries.—*Idem. April*, 1830.

3. *Huraulite and Hetepozite.*—Du Frenoy has analyzed these two minerals found formerly by Alluau in the Limoges. The Huraulite consists of phosphoric acid 38.00, protoxide of iron 11.10, protoxide of manganese 32.85, water 18. This mineral is in minute crystals of the size of a pin head. The primitive form is an oblique rhombic prism of 117° 30′, and 62° 30′; but it occurs in the form of rhomboidal prisms, with or without the acute angles replaced. It shows no cleavages; has a glassy fracture, and reddish-yellow color; is transparent; scratches calcspar, but is scratched by steel. Its specific gravity = 2.27. It fuses with great difficulty before the blowpipe, giving a black bead with metallic lustre. In a tube it gives off water. It occurs in the granite about Limoges. The only pieces yet found were picked up by Mons. Alluau, near Strassenban. The Hetepozite is composed of phosphoric acid 41.77, protoxide of iron 34.89, protoxide of manganese 17.57, water 4.40, silica 0.22. This mineral is found only in scaly masses, cleaving, however, in three directions, giving an oblique rhombic prism, having an angle of about 100° or 101°. The lustre is shining and fatty, like that of the apatites. The color greenish-gray or bluish. Weather-worn surfaces have a beautiful violet color and a semi-metallic lustre. These weather-worn pieces cleave with greater ease, and may be measured with the common goniometer.

The undecomposed scratches glass with ease, but not quartz. In its decomposed state it is softer, and is scratched by steel. The specific gravity of the former is 3.524, of the latter 3.39. It dissolves in acid with a slight residue of silica. Before the blowpipe it melts into a dark-brown enamel.—*Ann. de Chim. et de Phys.* xli. p. 337.

4. *Combinations of Iodic Acid with Vegetable Alkalies.*—It results from the experiments of M. Serulas, 1st. that morphine alone exerts a decomposing action on Iodic acid, from which it separates abundantly the Iodine, a character which may be taken as a distinction between this base and other alcoloids: 2d. quinine, cinchonine, strychnine, saturate Iodic acid perfectly, and produce well crystallized saline compounds.

It is supposed by the author that these new compounds of Iodine and vegetable bases, may be found to possess medical qualities of a valuable character.—*Idem.*

5. *Reduction of Metals by Azote.*—The reduction of palladium by the simple evaporation of its solution in the open air, induced N. W. Fischer, as early as 1827, to suspect that the azote of the atmosphere might operate as the agent of reduction. This change takes place in the solution of palladium, at common temperatures, and even when the solution contains much free acid. The solution of gold, if perfectly neuter, also manifests a feeble reduction.

To determine whether azote is the active principle, the author brought into contact with a common acid solution of gold, the gaseous oxide of azote, and the reduction of the metal was soon manifest. One portion was deposited on the sides of the vessel, and another covered the bubbles of air as they arose, with a metallic pellicle, and in a short time the gold was separated from the liquid.

The reduction is also effected by nitric acid. If a tube containing some solution of gold be placed in a bottle over fuming nitrous acid, the reduction takes place. But the gaseous oxide of azote and nitrous acid do not effect the reduction of palladium, nor probably of any other metal.

Evaporation appears to be a necessary condition in the reduction of silver and platina, for the azote is presented only in proportion as the acids of the salts are dissipated by evaporation.

In experiments upon the reducing power of azote, the light must of course be excluded.

The compound of oxide of azote and potash, which is always obtained by heating saltpetre to redness, after carefully separating all the other products from it, reduces the solution of gold promptly and completely, but it does not reduce the other metals.—*Bib. Univ. April*, 1830.

6. *Action of dilute Sulphuric Acid upon Zinc.*—In attempting to ascertain the kind or quality of zinc most suitable for voltaic instruments, Professor De La Rive was forcibly struck with the great difference which he found in the action of dilute sulphuric acid upon pure zinc, obtained by distillation, and the ordinary zinc of commerce. With the former, the action is very slow and feeble, and but little hydrogen gas can be obtained,—with the latter, which is always heterogeneous, the action, as is well known, is very great, and the evolution of gas rapid and abundant. The great difference, in these cases both with respect to the quality of the zinc, and the dilution of the acid, he justly conceived had not been sufficiently investigated.

To determine with precision the difference in the activity of these materials, in different states of purity and mixture, he employed a ground stopped flask or vial, of one ounce capacity, to the bottom of which was attached a lateral tube, which, being bent upwards, was graduated into equal parts, and was large enough to receive all the fluid contained in the flask. A cylinder of zinc being attached by wax to the glass stopper, and so adjusted as to be easily pushed into the acid, the quantity of gas disengaged in a given time, rising to the top, and forcing the fluid into the tube, could thus be measured with great exactness.

The mixtures of acid and water which he employed, were, in order, as follows.

	Density.	Quantity of acid in 100 parts of the mixture by weight.
No. 1.	1.137	20.20
2.	1.182	25.64
3.	1.215	29.85
4.	1.258	35.28
5.	1.326	43.25
6.	1.532	64.20

In making the experiments, care was taken that the initial temperature of the dilute acids were the same, and that the same surface of zinc was at each time exposed to it. The same quantity of gas was disengaged by the different mixtures, in times as follows:

	Acid No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Zinc of Comm.	0′ 6″	0′ 3″	0′ 2″	0′ 3″	0′ 4″	0′ 9″
Distilled Zinc,	3′ 30″	1′ 50″	0′ 30″	0′ 26″	0′ 24″	1′ 30″

The maximum of effect on the zinc of commerce was generally attained in ten minutes, while in the pure zinc, it required several hours, especially in a very weak acid. In No. 6, the action was most rapid, at the commencement, with both kinds of zinc.

It appears that the mixture No. 3, is the acid which produces the greatest quantity of gas in a given time with the zinc of commerce, viz. that which consists of 30 parts of sulphuric acid, and 60 of water.

The great difference thus manifest in the two kinds of zinc, is not owing, as Professor De La Rive ascertained, to a difference in sp. gr., for in this they were precisely equal. It appears therefore to be occasioned by foreign mixture, and to ascertain this, he added to a portion of distilled zinc in fusion, one ninth of its weight of iron filings, and he did the same with tin, lead, and copper filings, and of them he cast four cylinders, and obtained with them the following results.

	Dist. Zinc.	Tin Zinc.	Lead Zinc.	Copper Zinc.	Iron Zinc.	Zinc of Com.
Acid No. 1. temp. 10° cent.	3′ 27″	0′ 24″	0′ 12″	0′ 4″ to 6″	0′ 4″	0′ 4″
Acid No. 2. temp. 10° cent.	1′ 50″	0′ 12″	0′ 9″	0′ 6″	0′ 3″	0′ 3″
Acid No. 3. temp. 10° cent.	0′ 20″	0′ 12″	0′ 10″	0′ 3″ to 4″	0′ 2″ to 1″	0′ 2 to 1″

Cylinders of these different kinds of Zinc, being left at rest in No. 6, until the action ceased, the pure zinc alone gave a perfectly limpid

and transparent solution, the others left a residuum agreeable to the substance mingled with the zinc.

The author next ascertained by direct experiment, that the mixture of acid and water which produces the most lively chemical action upon Zinc, is that which is the best conductor in a Voltaic apparatus; and also, that if to a cylinder of distilled zinc which (as before stated,) requires 1′ 30″ to yield a certain measure of gas, a platina wire be attached, and immersed in the same fluid, an equal quantity is disengaged in 30″. Thus a cylinder of zinc having a fine platina wire wrapped around it, or otherwise attached to it, affords a larger quantity of gas than a piece of isolated zinc. It seems therefore reasonable to infer that in the production of hydrogen, by the zinc of commerce, and diluted sulphuric acid, the water is decomposed by a galvanic action. The zinc being positive, receives the oxygen, while the other metal being negative, allows the hydrogen to escape in the gaseous form, the quantity of which, in a given time, will depend on the energy of the electric current.

Prof. De La Rive states that he finds in the zinc of commerce some traces of tin, of lead, and a little more than 1 per cent of iron,* and his experiments have proved that less than two per cent of iron filings mingled with pure zinc, renders it as active with dilute acid, as the zinc of commerce.

The heat developed during the action of sulphuric acid on zinc is generally in proportion to the rapidity of the evolution of gas, and this, it is believed, arises also from the strength of the electric current.—*Bib. Univ. April*, 1830.

7. *On the production of Formic Acid.*—The fine discovery of Dobereiner, of the production of formic acid by the distillation of tartaric acid with sulphuric acid and the peroxide of manganese, is known to chemists. It has since been obtained by other processes. If a mixture be made of starch, peroxide of manganese, and diluted sulphuric acid, and heated in a large retort, an effervescence will at length take place, on account of the carbonic acid, and the mixture will have acquired a decided odor of formic acid. By continuing the distillation, formic acid will be obtained, accompanied by an odoriferous principle, very irritating to the eyes, but which becomes separated by the saturation of the acid with the bases.

Tunnerman, who first obtained formic acid by this process, took it for a peculiar substance, but Wohler shewed its real nature. Leibig,

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* Prof. De La Planche finds also in the zinc of commerce a considerable portion of cadmium.

about the same time observed that not only starch, but several other vegetable substances, produce formic acid, when treated in the same manner. Gmelin procured it from sugar, ligneous matter, althea roots, mucic acid, &c. but it was always soiled, especially when obtained from starch, by a substance which might be separated by decomposing its salts by sulphuric acid.

A very pure acid may be obtained by distilling alcohol with sulphuric acid and the peroxide of manganese; but to prevent the formation of sulphuric ether, it is best to employ diluted alcohol, or common brandy; for if the alcohol is concentrated, there is formed, besides sulphuric ether, formic ether, which not only would diminish the quantity of formic acid, but the latter would give with lead, a colored salt, difficult to crystallize. Acetic acid, subjected to the same treatment, yields no formic acid. The fibrine of blood has produced it, but very impure.—*Ann. de Chimie et de Physique, Fev.* 1830.

8. *Theory of the Electric Pile.*—In the first part of Berzelius' Chemistry, this subject is discussed with the author's usual sagacity. In commenting on the experiments of Prof. De La Rive, who supports the chemical theory, he finds one equally opposed to both theories. "If a glass tube be bent in the form of a U, into the one end of which is put sulphuric, and into the other nitric acid, so as to keep them unmixed, and if an arch of zinc and copper be so placed that the zinc shall be in contact with the former, and the copper with the latter, no chemical action takes place in the sulphuric acid, but the copper is dissolved by the nitric; nevertheless, the zinc is positive, and the copper negative, contrary to what ought to follow if the chemical action were the source of the electricity." To remove the powerful objection to his opinion to which this seems to give rise, he shows that if the arch consist of one metal only, the direction of the stream is still the same, though its intensity is less. Hence, says he, it is clear that when a single metal produces a stream in the same direction as two, the contact between two, copper and zinc, cannot have been the cause of the stream; but in his eagerness to overthrow Volta's theory, De La Rive seems to have forgotten that the result of the experiments controverts as strongly the opinion he wishes to support, that the chemical action is the primary cause of the electrical phenomena, since while the chemical action is in the one acid, the direction of the chemical phenomena is from the other. He endeavors to explain this on the principle, that the electrical stream finds greater difficulty in passing from the copper to the sulphuric acid, than from the latter to the nitric acid, but that is to let a slight hindrance overcome a powerful action.

But it is obvious that this experiment affords another argument still in favor of the conjoined influence of the two generally assigned causes as held by Berzelius. For if, when the arch of metal is of copper alone, the electricity is of small intensity, and yet, without any addition to the *apparent* chemical action, becomes of greater intensity by merely replacing a portion of the copper by a wire of zinc, it is evident that the circumstance of contact has an influence, if not in the primary developement of the electricity, at least in making it sensible. Or if the action of the nitric acid upon the copper appear to increase by making the arch in part of both metals, while at the same time the electrical intensity is increased, it might even be presumed that the *contact* of the two metals influences the primary developement itself of the electricity. At all events, it does seem, both from this experiment, and from the phenomena of the compound piles described by Berzelius in his Lärbok, which De La Rive has endeavored, though unsatisfactorily, to explain, according to his own views, that at present we cannot entirely account for all the appearances of bodies influenced by galvanic electricity, by either of the theories taken alone.

Watkins has carried the simplicity of this combination of De La Rive still further. He has succeeded in forming a pile of perceptible tension, with plates of zinc alone, polished on the one side, and rough on the other, without any moist conductor. They are placed in a wooden frame, parallel to each other, at a distance of one or two millimetres, so as to have a thin layer of air between each. The combination is, air, rough zinc, smooth zinc, air, &c. and the rough zinc is positive, as when the place of air is supplied by a liquid. This has been explained like De Luc's pile, by the oxidizing affect of the air; but it is difficult to conceive that such arrangements can owe their polarity to any chemical action upon the metallic surfaces, since Berzelius, in commenting upon this opinion of Davy, in his Arsberättelse for 1827, states, that he has kept a pile formed of brass and tin papers, in which the tin is the positive metal, in activity for eight years, and yet the tin paper remained to the last, *as pure and brilliant as when first employed.* And that the moisture of the paper which was supposed to be instrumental in causing oxidation, has no connection with the electro-motive agency, has been long ago shown by the experiments of Jager, in whose piles the papers were dried and sealed up with a non-conducting body, at the temperature of 140° Fahr., so as to be air-tight, and yet continued in activity. These phenomena cannot be explained without having recourse to something more than chemical action, "which seems by no means necessary for the developement of the electrical elements in the dry pile. The absence

of chemical phenomena may be remarked by the small quantity of electricity, and the great tension in proportion to it. Independent of chemical phenomena, they may possibly depend upon the unequal conducting power of the metals employed, and their consequent unequal capacity for electricity in its distributed or polarized state, which must be greater in good than in bad conductors."—*Edinb. Jour. of Science, July*, 1830.

9. *Heat of the Planetary Space.*—It is known that Fourier, in his valuable researches into this subject, deduced from the laws of radiant heat that the temperature of the planetary space is —50° cent. =—58° Fahr., and that the earth has nearly reached its limit of cooling. Suanberg has built his researches upon a different principle, and has obtained the same result. From his letter to Berzelius on this subject, we extract the following:

"Led by these considerations, and by the many known affinities between light and heat, which are especially remarkable in the acknowledged property of solar light, to develope heat in opaque and imperfectly transparent bodies, I began by supposing that the planetary space (considered as perfectly pellucid,) never undergoes any change of temperature, either from the action of light or of radiant caloric, and that, therefore, the capacity for elevation of temperature above what reigns in the ethereal regions, can exist only within the limits of the planetary atmosphere. Further, that the rapidity of the change of temperature at an indefinite height above the surface of the earth, is always proportional to the rapidity of the atmosphere's corresponding change of capacity to absorb light. In this way I obtained the temperature of the atmosphere, (expressed in a function of an indefinite height above the earth's surface,) containing only two arbitrary constants, of which the one is also a function of the time, and is determined always by immediate observation of the given temperature at the moment on the earth's surface; the other, namely, the temperature of the planetary space, is constant, even in regard to the time. The numerical solution presupposes accurate observations of temperature at isolated points to a considerable height above the earth's surface, which, however, are unfortunately so extremely few that we can have recourse among newer observations to but a single one, that of Gay-Lussac, in his aeronautic expedition. It were to be wished that the same experiments were repeated, particularly in the neighborhood of the equator, where the oscillations around the mean state of the atmosphere, and consequently the prejudicial influence of accidental circumstances are less to be dreaded. In the mean time, availing myself of this observation, I have obtained for the planetary

space a temperature of — 49.85° cent., which differs only by one seventh of a degree from the result of Fourier, deduced from the laws of heat radiated from the mass of the earth, the temperature of which he supposed to have reached its asymptotic state of absolute unchangeableness on the whole. Without believing in the identity of light and heat, or in the certainty of our photometric knowledge, I have thought it not etirely void of interest to see what results, in relation to this point, could be obtained from Lambert's statements, in regard to the absorption which takes place in a ray of light passing from the zenith through the whole atmosphere, calculated on the supposition that the differential of the increase of temperature is always proportional to that of the absorbed light. By this process I have obtained for the required temperature — 50.35°. I was most agreeably surprised by so remarkable an agreement between both of these results and that which Fourier derived from principles so different; and it affords an additional reason why the function I have given for the temperature should be taken into due consideration. The immediate results of the same are, that the temperature diminishes with a constantly diminishing velocity, as we ascend in the atmosphere, and that even at a given height, this velocity is greater, the higher the temperature at the earth's surface.—*Idem.*

10. *Sulphuret of Cyanogen.*—Lassaigne,* by mixing perchloride of sulphur, with twice its weight of cyanide of mercury, and leaving them some days in a flask, has obtained a colorless crystalline sublimate, which is a new compound of sulphur and cyanogen, having the following properties: it sublimes spontaneously in rhomboidal scales, which powerfully decompose light. It is very volatile, has a pungent odor, and seems to act with considerable energy on the animal economy. Exposed to air and light, it soon becomes yellow. It dissolves both in water and alcohol. Its solution in water reddens litmus, and gives a red color to the salts of iron. This is the only compound of these two elements which has hitherto been obtained in an isolated state. It contains twenty four per cent. of sulphur, and may therefore be considered as a disulphuret of Cyanogen; we have therefore three known compounds of sulphur, and cyanogen. 1st. 1 atom of sulphur + 2 atoms cyanogen.—2d. 2 atoms sulphur + 1 atom cyanogen.—3d. 4 atoms sulphur + 1 atom cyanogen.

The first is the sulphuret of cyanogen of Lasssaigne. The second the base of the sulphocyanic acid of Porret.

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* Poggendorf's Annals, XIV. 532.

The third is the base of the sulphuretted sulphocyanic acid of Berzelius, a yellow compound obtained by heating sulphur in prussic acid and vapor.—*Idem.*

11. *Magnesium.*—Bussy* has obtained this metal in the form of a brown metallic powder, not oxidizing by a contact with air, water or dilute nitric acid, but dissolving in caustic potash and muriatic acid, and at a high temperature burning with a residue of magnesia. He prepares it by passing potassium in vapor over dry chloride of magnesium.—*Idem.*

12. *Fulminating Silver.*—† Mitscherlich's mode of preparing this substance is very simple. He dissolves a silver salt in caustic ammonia to saturation, and adds caustic potash in excess. The fulminating silver falls immediately, and more is obtained by heating till the ammonia is driven off.—*Idem.*

13. *Red Lead.*—This substance is generally supposed to be a mixture of protoxide and peroxide of lead in variable proportions. "In some very beautiful red lead," says Dr. Thomson "I have found the proportion of protoxide amount to nearly one half of the whole weight. Acetic acid dissolves out the protoxide and leaves the peroxide untouched." Fischer has shown that red lead dissolves in *concentrated* acetic acid, giving a clear colorless solution, which in a close vessel undergoes no change. Water decomposes it, and throws down the brown oxide. "I have repeated this experiment," says Berzelius, "and find that a small quantity of acid converts the minium into a colorless salt; a larger quantity dissolves it. Heat throws down the brown oxide without previous dilution. This seems to show that red lead is not, as some have supposed a compound of two oxides." If so, it will be the sesqui-oxide of lead.—*Idem.*

14. *Fusibility of Salts.*—A mixture of five parts carbonate of potash and four carbonate of soda, melts more easily than either separately. Mitscherlich has applied this to the decomposition of mineral substances, which takes place with such ease in this mixture, that as much as two hundred and twenty grains may be melted over the flame of a lamp. Sand thrown into it in small portions dissolves immediately with evaporation, exactly as when an acid is poured upon an alkali.—*Idem.*

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* Journal de Chimie Medicale, IV. 856.

† Poggendorf's Annals, XII. p. 143.

15. *Vegetable Chemistry.*—Animal and vegetable chemistry afford to the man of Science, the most astonishing field of contemplation. He sees all the varieties of vegetable nature reducible to four elements, and animal products in general made up of the same number, and yet there is no end to their combinations, and none can tell the limits within which the changes of nature wrought through the aid of such scanty materials must be confined. Yet this beautiful simplicity has hitherto rendered the study of her combinations perplexing, and we have been unable often to discover such differences in atomic constitutions as at all to account for the diversities in external appearances and character of many vegetable and animal substances. But our knowledge is enlarging, and, as the resources of organic analysis become greater, it is to be hoped that we shall by degrees attain, if not to a complete, at least to a much less imperfect view of the chemical constitution of organized bodies than we can yet boast of.—*Idem.*

16. *Camphor.*—Libri has mentioned a curious circumstance regarding odoriferous bodies such as camphor; that if they be exposed to a current of electricity for a considerable time their smell diminishes, and at last disappears entirely. After a lapse of time, camphor again recovers the power of emitting odors.—*Idem.*

17. *Geology.*—In connection with Geology, we shall advert to C. G. Gmelin's elegant examination of Clinkstone. He has found that this volcanic rock is an aggregate of mesotype and felspar. He shows this in a very interesting way. He treats the mineral with muriatic acid, and separates the dissolved portion, after which the silica of the decomposed part is dissolved out by boiling with carbonate of potash. In the mesotype, a portion of the soda is compensated by potash and lime, and a part of the alumina by peroxide of iron and manganese, and in like manner, in the felspar, a part of the potash is compensated by soda and lime, and of the alumina by oxides of iron and manganese. In this investigation the water in the mesotype was found to be less than in the same substance when crystalized. The water might possibly be merely hydroscopic, as its quantity in the mineral varied from 0.633 to 3.19 per cent. It is probable that the application of this principle to other rocks might be productive of very interesting results, and might throw light upon geological formations, which we shall seek in vain from the analysis of specimens of rocks in the aggregated state.—*Idem.*

18. *Populine.*—It was announced to the French Academy on the 6th of September last, by Gay-Lussac that M. Braconnot, of Nancy,

had discovered, in the poplar, the substance called Salicine, and another substance which he regards as new, and which he has named *populine.—Rev. Encyc. Sept.* 1830.

19. *Coloring matter of blood.*—At the same session of the Academy, *Gay-Lussac* and *Serullas* made a report on the memoir of M. Lecanu, relative to the coloring matter of blood or hematosine. In recapitulating, say the reporters, what precedes, we find that the coloring matter of blood or hematosine is not an immediate principle, but a combination of albumine and a particular coloring substance, which M. Lecanu, by the aid of an easy process, which he carefully describes, has succeeded in isolating. He proposes to name it *Globuline* in assigning to it the following characters. 1st, of being of a beautiful red in the condition of hydrate, and of a brown red when dry. 2d. of containing (which is easy to prove by incineration) 0.174 of its weight of iron, that is to say, double of what was found in the matter of Berzelius, and consequently proportional to the quantity of albumen separated from it; 3d. of being "very soluble in alkalis, and much more so than coagulated albumen, for two or three drops of potash-water, or ammonia are sufficient for the prompt solution of several grammes of it. 4th. of forming with hydrochloric acid a compound soluble in concentrated alcohol. This last is one of its most remarkable properties. These facts which have been clearly stated, and which have required much experience to establish them, render the memoir of M. Lecanu deserving the approbation of the Academy." (Approved.)—*Idem.*

20. *Water in red hot vessels.*—M. Le Chevalier infers from his experiments, that water in red hot vessels has, probably, a temperature below 100° Centigrade, and that water at a boiling heat would cool if poured into a red hot crucible.—*Rev. Encyc. Aout*, 1830.

21. *Tendency to crystallization.*—There is a curious property of many salts which I have seldom seen adverted to, but which is nevertheless extremely deserving of attention. We commonly describe salts in their crystalline state only, and attend little to their habits in their amorphous state.

And yet, in this state, they occasionally exhibit very interesting phenomena. Some salts, when deprived of their water by fusion, deliquesce on cooling, and run into a liquid in which crystals are afterwards gradually deposited till the whole has assumed the form of a crystalline salt, containing water, and permanent in the air. Others attract only so much moisture as to admit of an internal motion of the

atoms, and assume a crystalline arrangement without becoming liquid, of which kind is common barley sugar, as has been shown by Mr. Graham. The chloride of gold and potassium is an efflorescent salt, and when left to itself gradually falls to powder. Yet the large crystals employed in the former of the two experiments above detailed, after heating to the fusing point, and losing by that means upwards of nine per cent., being set aside for a couple of days, had reached, at the end of that time, within a half per cent. of their original weight. Such an attraction for moisture we are not prepared to expect in an efflorescent salt, but all these phenomena are probably due to a tendency, with which I consider all matter to be endowed, to assume regularly crystallized forms, and to attract to themselves such neighboring substances as may aid that tendency. The proneness to crystalline arrangement, however, is not to be recognised as any new principle, but simply as an uniform result of universal mechanical laws.—*J. F. W. Johnson, in Brewster's Journal, July,* 1830.

22. *Preparation of phosphorus.*—Wöhler recommends, as likely to give phosphorus at a very cheap rate, to distil, by a strong heat, ivory black with half its weight of fine sand and charcoal powder. A silicate of lime is formed, and the carbonic oxide and phosphorus comes over.—*Pog. Ann. de Phys.—Idem.*

23. *Discovery of Bromine in the Baltic.*—M. Kastner, in the *Archiv für die Ges. Naturlehre,* announces the discovery of bromine and iodine in the waters of the Baltic, near Swinemunde.

24. *New compound of chlorine, phosphorus and sulphur.*—A new compound of these elements has been formed by Serullas. There are two chlorides of phosphorus, consisting of

	Per-chloride.	Proto-chloride.
Phosphorus,	1 atom	1 atom
Chlorine,	5 atoms	3 atoms.

When the per-chloride is introduced into an atmosphere of dry sulphuretted hydrogen, it becomes heated, and changes in a short time into a colorless transparent liquid; while muriatic acid vapor takes the place of the sulphuretted hydrogen. When purified by distillation in a small retort, this compound has the appearence of the purest water. It is heavier than water; has a peculiar pungent aromatic smell, mixed with that of sulphuretted hydrogen; fumes slightly in the air, and boils at 125° Centigrade. The odor of sulphuretted hydrogen is owing to the action of atmospheric moisture, for, when de-

composed by oxide of copper, it gives no trace of hydrogen gas. Its composition by the analysis of Serullas, is three atoms chlorine, one atom phosphorus and one atom sulphur.—*Idem.*

25. *Atomic weight of iodine and bromine.*—M. Berzelius has determined that the atomic weight of iodine is 789.145, and the density of its vapor 8.7011. The atomic weight of bromine seems to be about 489.15, and the density of its vapor 5.3933.—*An. de Chim.*—*Idem.*

26. *Economic Lighting.*—At the Tulloch Bleachfield, a young man, named A. Reed, has constructed an apparatus, by means of which he is enabled to procure from the wood, which they are in the practice of burning, in order to obtain acetic acid, gas sufficient to light the whole premises. By this ingenious device a most important saving is effected, since no more wood is necessary for both the gas and the acid, than was formerly used for the acid alone.—*Lond. Mechan. Mag. Jan.* 2, 1830.

27. *Decomposition of Water.*—In order to determine the power of a small galvanic battery of twelve pairs of four-inch plates, on Dr. Wollaston's plan, *L. Rickard* states, that he brought the wires from the two poles into contact with the platina wires of two glass tubes, three-eighths of an inch in diameter, and three inches long, filled with water, and placed in a glass containing the same fluid. Exceedingly minute bubbles of gas rose in the tubes, but it would have required many hours to procure a quantity sufficient for determining its properties, when by accident a small quantity of dilute nitric acid was poured into the glass containing the tubes. Immediately great quantities of gas arose in both the tubes, and again, when a small quantity of pure nitric acid was poured into the glass, the power of the battery was so considerably augmented, that the tube in connection with the negative pole, was filled with gas in a few minutes. The gases proved to be oxygen and hydrogen in proper proportions, whence it was inferred that the nitric acid somehow increased the power of the battery, without being itself decomposed.—*Idem.*

28. *Homogeneous and Heteromorphous Compounds.*—A letter from Berzelius to M. Dulong, was read to the French Academy on the 9th of August, in which he states that his analysis of tartaric acid differing from that of Proust, in which he had great confidence, he repeated it, and obtained the same result as Proust. But, after having analyzed

an acid, latterly known in Germany under the name of acid of Vosges, (Voghesen-Laure) he found that it had the same composition and the same atomic weight as tartaric acid. Its characters, however, and the crystalline forms of its compounds, are different from those of tartaric acid and the tartrates. The two kinds of salts, taking the same number of atoms of water, and the same species, being heteromorphous, it is proved that bodies composed of the same number of elements, in the same proportions, may have different chemical properties, and be heteromorphous. This it may be perceived is the reverse of the isomorphism of compounds formed from different elements in the same proportions. There are several known examples, analogous to that of the true tartaric acids, both of organic and inorganic compounds. Such are the old phosphoric acid, and the calcined phosphoric acid; the two stannic oxides; fluid albumine, and coagulated albumine. Berzelius proposes to give the name of *isomeres* to those compounds whose properties are different and composition identical, and to distinguish these isomaternal compounds from each other, to precede the name of one of them with the Greek preposition παρα. Thus we should say phosphoric acid, para-phosphoric acid, &c.—*Rev. Encyc. Aout*, 1830.

29. *Bitter Almonds.*—An able memoir on the constituents of this substance, by Robiquet and Boutron Charlard, was favorably noticed in the French Academy on the 23d of August, by *Thénard* and *Serullas.* The authors prove, 1st, that the volatile oil of bitter almonds is not all formed in the fruit; that water is necessary to its production; 2d, that Benzoic acid is not precipitated in the volatile oil, but that the latter is susceptible of being entirely converted into Benzoic acid by the absorption of oxygen; 3d, that there exists in bitter almonds a peculiar crystalline matter, white, inodorous, unalterable by air, of a bitter taste, very soluble in alcohol, and crystallizable by cooling in radiant needles; susceptible of being disengaged from ammonia, when heated with a solution of caustic potash: that this substance, which the authors name *amygdaline*, may be the only cause of the bitterness of this fruit, and one of the elements of its essential oil, in which they are induced to admit the existence of a benzoic radical.—*Idem.*

NATURAL HISTORY.

1. *Meteoric Iron in Bohemia.*—The locality where this mass of meteoric iron was found, is the slope of a hill near the castle of Bohumilitz, in the circle of Prachin in Bohemia, the estate of Baron

Malowetz of Skalitz. A ploughman, having on the 19th of September 1829, accidentally alighted upon it with his plough, and supposing the mass which was afterwards found to weigh one hundred and three pounds, to be an ordinary stone, he endeavored to lift it, and throw it out; but being surprised with the great weight, he thought it must be a precious metal. A small bit of it, however, having been detached by a blacksmith with a hammer, it was recognized to be iron. Dr. Charles Claudi, an eminent lawyer of Prague, the proprietor of the neighboring estate of Cykin, paying a visit to the baron, was shown the mass, and as there are no iron works in the vicinity, he argued that it might have had a meteoric origin. This was fully confirmed by Professor Steinman's discovery of nickel in it, and by the peculiar structure which is likewise detected in other kinds of meteoric iron by etching a polished surface. Upon the application of these gentlemen, Baron Malowetz presented the whole of this highly remarkable object to the National Museum at Prague.

There can be no doubt that this mass of iron has lain a long time in the soil, the plough having passed over it for ages; and it must be ascribed only to the heavy rains of last summer, that, much soil having been washed away, it came at last within the reach of the plough. Its having been a long time exposed to the agency of the air and weather, is also testified by a thick crust of oxide, with which it was covered, when first dug out.

No conjectures can be made respecting the age of this mass. There is indeed a notice by Marcus Marci De Krouland, that a metallic mass had fallen from the sky in Bohemia, in the year 1618, but without giving the locality where it had fallen.

According to the account by Professor Zippe, the Bohumilitz meteoric iron is an irregular lump of a somewhat quadrangular shape. It is marked on the surface with irregular roundish impressions, of the same kind as other masses of native iron, having a meteoric origin. He describes the color of the surface as clove-brown, with spots of ochre-yellow, owing to the oxidation of the surface, which is covered with a crust of the brown hydrate of the peroxide. Within, the color is paler than the color of newly filed bar iron, but not so pale as that of the Elbogen native iron. Professor Steinmann found the specific gravity to be 7.146. On dissolving the substance in muriatic acid, hydro-sulphuric acid was developed, which being introduced into a solution of acetate of lead, gave a small quantity of a precipitate of sulphuret of lead.

A small residue of 1.12 per cent. of the whole which was left was insoluble even in nitro muriatic acid. It proved to be a mixture of

plumbago, and of small metallic scales of a steel gray color. The solution in muriatic acid being boiled with nitric acid in order to bring the iron into the state of peroxide, was decomposed by carbonate of potassa, and the precipitate digested with caustic ammonia. The blue ammoniacal solution left gave a residue of 5.11 per cent. of oxide of nickel, by evaporation and sudden ignition.

The result of the analysis of the Bohumilitz meteoric mass is therefore:

Iron,	94.06
Nickel,	4.01
Plumbago, with another metallic substance not sufficiently ascertained,	1.12
Sulphur,	0.81
	100.00

Dr. Brewster's Journal, July, 1830.

2. *Burning Coal Mine at New Sauchie.*—It is now more than two years since the snow lying on a field on the farm of Shaw Park, belonging to the Earl of Mansfield, was observed to melt almost as soon as it fell, and then rise in a state of vapor. The phenomenon attracted the attention of the managers of the Avon and Devon Collieries, and was found to be the effect of the heat produced by a stratum of coal in a state of ignition, technically known by the name of the nine feet seam, from which the Devon iron works are supplied with a large proportion of their fuel. Various plans were at the same time suggested to extinguish the flames, and after several failures, it was determined to cut a mine round the seam, to prevent their extension. Workmen were set to excavate this mine, which was opened at both sides of the seam, to build a wall as they proceeded, on the sides of the two tunnels next the fire. In this way it was intended to proceed, till the tunnels penetrated beyond the fire, when they were to be joined in the form of a horse shoe, and thus cut off, by means of a strong wall, all connection between the ignited part of the seam and the remainder of it. This plan has been persevered in for a year and a half, but has never been completed. The workmen have often brought the two walls within a few fathoms of meeting, but owing to the fire bursting in upon them, they have been hitherto obliged to fall back again and take a wider circle. Six or seven shafts have been sunk to ventilate the tunnels, in which the heat is frequently so great as to raise the thermometer from 212° to 230° of Farenheit;—it sometimes rises still higher. The lamps of the miners which are hung upon the walls, have more than once fallen to pieces from extreme heat.—*Idem.*

3. *Memoir on the nerves of Fishes.*—A subject which had been given out for competition for the highest prize in the Natural Sciences, by the French Academy, was an anatomical description of the nerves of fishes. The Academy at its session on the 19th of July, had received but one Memoir. This was written in latin, and accompanied by the most finished drawings, representing the distribution of nerves in the *Perca Lucioperca*, the *Eson Lucius*, and the *Petromyzon Marinus*. The memoir contained many excellent observations, and a history, almost as complete as it was possible to expect of the nerves of the first two species. It was much less perfect in relation to the third, as the writer himself admitted. Nevertheless the Academy, with a view to contribute to the perfection of this work, and to its publication, granted, on the principle of encouragement, the entire premium of *four thousand francs*, which had been appropriated to the proposed object.—*Rev. Encyc. Juillet*, 1830.

4. *On the connection of the Solfaterra with Vesuvius.*—On this point and on the interesting question of the subterranean cavity before the area of the solfaterra, on both of which I have in this paper strongly expressed my opinion, I have the satisfaction of being able to cite the authority of Sir Humphry Davy, a philosopher whose sober judgment so admirably tempered his ingenious sagacity, as to render even his hypothetical deductions highly valuable. He observes: There is no question but that the ground under the Solfaterra is hollow, and there is scarcely any reason to doubt of a subterranean communication between this crater and that of Vesuvius. Whenever Vesuvius is in an active state, the Solfaterra is comparatively tranquil. I examined the bocca of the Solfaterra, on the 21st February, 1820, two days before the eruption of Vesuvius was at its height. The columns of steam, which usually arise in large quantities when Vesuvius is tranquil, were now scarcely visible, and a piece of paper thrown into the aperture did not rise again, so that there was every reason to suppose the existence of a descending current of air. The subterraneous thunder heard at such great distances, under Vesuvius, is almost a demonstration of the existence of great cavities below filled with aeriform matter, and the same excavations which in the active state of the volcano throw out during so great a length of time, immense volumes of steam, must, there is every reason to believe, in its quiet state, become filled with atmospheric air.—*Brewster's Journal, July*, 1830.

5. *Iron Pyrites.*—It is known to mineralogists, that common or octohaedral pyrites and the white pyrites, which from their difference of form were considered by Haüy as different species, were found by

Berzelius to be identical in composition, or at least that no such difference existed as to warrant their being considered as different species. The explanation then given by Berzelius has been confirmed by later experiments, and he has published the following additional remarks: "When a portion of common pyrites was permitted to fall assunder, I found it to be caused by the formation of a small quantity of proto-sulphate of iron, which burst asunder the crystallized mass. When the salt was dissolved in water no trace of free sulphur was obtained, from which it appeared, that the efflorescing pyrites contains particles of FeS (sulphuret of iron,) which, changing to the state of salt, tears asunder the rest which undergoes no change. When the small quantity thus changed into sulphate of iron is compared with that which remains unaltered, I did not think that the results of analysis could be obtained to such a degree of accuracy as to determine the matter with certainty. I have since obtained a satisfactory proof of the accuracy of this explanation. I heated carbonate of iron gently in a stream of sulphuretted hydrogen. There were formed first *sulphuret*, and afterwards *bi-sulphuret* of iron. The experiment being stopped before all the iron was changed into bi-sulphuret a pyrite was obtained, which in a few days fell asunder in all directions, and changed into a woolly mass of vitriol of ten times its former volume. Sesqui-sulphuret of iron prepared from the oxide has not this property. It seems, therefore, highly probable, that the falling asunder of the common pyrites, arises from the electro-chemical action of the electro-negative bi-sulphuret which is here and there mixed with it in small particles.—*Berzel. Arsberät.* 1829, *p.* 129.

Kohler finds the specific gravity of common pyrites to vary from 4.826 to 4.837; of the octohaedral from 4.8446 to 4.9074; and that of the cubical to be 4.9188.—*Poggend. An. XIV.* 91.

6. *A notice of the Mammoth*, (Elephas primigenius,) has been occasioned by the recent discovery of a fine jaw of this fossil animal, in the river Oca, near Mourum. We are informed that the true indiginous name is not Mammoth but Mammont, and that a notice of this fossil was published as early as 1696 at Oxford, by Ludolf in his *Grammattica Russica.* Prof. Fischer has distinguished six species confounded under the name of Mammont: and he has given the characters of them in the new memoirs of the Society of Naturalists of Moscow, Vol. I. p. 255; they are called *Elephas mammonteus*, E. panicus, E. proboletes, E. pygmæus, E. cámpylotes, E. Kanieuskii.—*Bib. Univ. Aout*, 1830.

7. *Virus of Small Pox.*—A communication from Dr. Ozamann of Lyons was read at the French Academy on the 4th of August, in which the writer states; 1st that he has ascertained that the matter of small pox, if mixed with fresh cow's milk, produces an eruption similar to that of the Vaccine virus, and has the same faculty of propagating the Vaccine disease innate in man, but that it was imported into Europe about the 6th century, by the Moors of Spain; 2d that the Vaccine is real Variola but of the most benign species; 3d that by inoculating with the Vaccine virus alone, or with that of Variola mingled with fresh cow's milk in very small quantity, we obtain generally as many punctules or punctures, and that the pustules are the real small pox, which guarantees children from this malady, in its state of malignity. Hence there need be no want of vaccine matter, for if the small pox make its appearance in any district, by taking the matter from a pustule on the 6th day after the eruption, that is, when the liquid it contains is fluid and clean, mixing it with milk, and inoculating with this mixture, the result will be the same as with Vaccine matter.—*Rev. Encyc. Aout*, 1830.

MECHANICAL PHILOSOPHY.

1. *Roman Aqueducts.*—In an *Essay on the means of conducting, raising and distributing water* by M. Genieys, Engineer, &c. 4to, pp. 315, Paris, 1829, the author states, in a historical account of the principal hydraulic works of the Romans, that the total length of the aqueducts employed in the distribution of water through ancient Rome was forty three myriameters or 107 post leagues. Three fourths of this length were subterranean vaults; eight leagues were in arcades raised to the height of thirty two metres; and the volume of water furnished by the aqueducts was seven hundred and eighty five thousand cubic metres in twenty four hours.

The fountains of Rome are still an object of admiration, not so much on account of their beautiful architecture and their sculptured ornaments; as for the torrents of water which they diffuse. The Pauliric fountain dispenses daily thirty six thousand cubic metres, and that of St. Peter's at the Vatican, consisting of a simple pipe raised upon a pedestal, distributes six thousand, while the jet in the Palais Royal, so much admired in Paris, emits but one thousand seven hundred cubic metres in twenty four hours.

Notwithstanding our acquaintance with this branch of physico-mathematical science as evinced by the immense works of Versailles executed under Louis XIV. and the most learned researches and experiments by French Sçavans, few of our cities (France) possess

any system in the distribution of water, and London, Glasgow, Edinburgh and Philadelphia are now more advanced in this respect, than Paris. This city however will soon have no cause to envy others on this head. Eighty thousand cubic metres, brought by the canal de l'Ourcq, are to be daily devoted to the embellishment of the places and promenades of Paris, to the watering of its streets and the washing of its sewers: and forty thousand metres drawn daily from the Seine by steam engines, are to be conducted through iron pipes to receivers in every house at different heights according to the wishes of the owners. —*Rev. Encyc. April*, 1830.

2. *Optical Instruments.*—In a Report of Francoeur, relative to the optical Instruments of *Lerebours, Cauchoix, et Vincent Chevallier*, it is stated that M. Cauchoix being in possession of a piece of Guinand's flint glass, has worked it into an objective of eleven inches diameter and eighteen feet focus; that this beautiful piece constitutes part of the telescope which Mr. South has used with so much effect in England. A recent letter from this distinguished astronomer to the Reporter, informs him that he can easily perceive with this instrument nebulous stars whose existence was contested, and that he had discovered others, impossible to be observed with any other instrument. Rock crystal is less dispersive, and more refractive than any crown glass, and the employment of it would be exceedingly valuable in large telescopes, but the working of this substance is extremely difficult on account of its hardness and its double refraction. The substitution of this crystal for crown glass, shortens the length of instruments one third. The two rings of Saturn may be seen distinctly with a telescope of this kind, of only thirty inches focus and forty five lines of aperture. This result is due to M. Cauchoix. This able mechanist has also resolved the important problem of constructing the supports of a telescope so as to sustain the centre of gravity at every inclination, without which it is difficult to use long instruments, for the more a telescope magnifies, the more rapid is the motion of stars in the field of view, and the more difficult it becomes to keep the axis properly directed. He has therefore rendered an eminent service to Science by his ingenious movable support. The gold medal was adjudged to him for his improvements.

The silver medal was granted to V. Chevallier, pere et fils, for their improvement in microscopes. They have made achromatic lenses of four, three, and even two lines focus. They were the first to construct the *Amician* microscopes and this philosopher has acknowledged that their instruments magnify to the extent of six or seven thousand times.—*Bull. D'Encour. May*, 1830.

3. *Phenomenon of immiscible fluids.*—Dr. Hancock has ascertained that when a portion of sulphuric ether and proof spirit in equal parts, is added to laurel oil, the latter, although a fluid of greater specific gravity, invariably occupies the upper part, or *floats on the surface of the compound of ether and proof spirit.* The result is identical whether the oil or the compound be poured in first, or whether the vial be shaken, or the materials be added in the gentlest manner. The sp. gr. of the oil which he tried was, to that of the ethereal mixture as twenty one to seventeen.

Dr. Hancock attributes this curious apparent aberration from the common laws of sp. gr. to the "strong affinity and combination of the laurel oil with ether, by which it is attracted and separated from the water and alcohol." Pure ether and pure laurel oil combine intimately, but the author does not state whether this compound is lighter or heavier than that of ether and proof spirit.—*Dr. Brewster's Journal, July,* 1830.

4. *Phenomenon of revolving motion in fluids.*—Dr. Hancock finds that if some rectified spirits of wine be dropt at intervals into a vial of laurel oil, a circulation commences of globules of alcohol up and down through the oil, which will last for many hours or for days. A revolving or circular motion also appears in the oil, carrying the alcoholic globules through a series of mutual attractions and repulsions, the round bodies moving freely through the fluid, turning short in a small eccentric curve at each extremity of their course, passing each other rapidly without touching, but after a time, seeming to acquire a density approximating to that of the lower stratum, which appears to be an aqueous portion, separated by the ethereal oil from the alcohol, and this assimilation taking place, the globules, after performing many revolutions, will fall flat upon the surface, and unite with the lower or watery stratum. Larger globules will occasionally separate and revolve, and smaller ones will leave their course and revolve about the larger, like secondary planets about their primaries. The experiment, he observes, is well worth the trouble, and may possibly serve towards an illustration of the celestial motions.—*Idem.*

5. *Laws of the living organism,* or the application of physico-chemical laws to Physiology.—A work with the above title by Dr. A. Fourcault, which deserves (says the Journal *des Progres des sciences et Institutions medicales*) to be read as well on account of the erudition it displays, as for the talent and intellectual vigor of the author, concludes with the following recapitulation of the principles which it maintains:

1. There exists in the immensity of space, vast electro-motive bodies, formed of ponderable matter, which act mutually upon each other at infinite distances, by means of imponderable fluids.

2. The electric fluids whose existence is proved by their action on the organs of sense, and by the general phenomena, must be considered as the universal cause of attraction and repulsion, as well as of the aberrations which the great masses of matter undergo.

3. These fluids produce an attraction of the masses when their currents are in the same direction and move with an unequal intensity; they produce a contrary effect when the currents are in opposite directions and move with an equal intensity.

4. The solar fluid, or resinous electricity is the universal agent in the motions of life. The solar action cannot be considered abstractedly; according to the opinion of the polarists, if we admit polar forces, or those of attraction and repulsion without the intervention of electric fluids, is to slide into ontology.

5. Light and heat are effects of the action of these fluids upon the sensitive system of men and animals. Caloric results from their combination or neutralization.

6. Life, which is only a succession of atoms and physico-chemical, intra-organic combinations cannot be maintained but by means of the action of these fluids, combined or uncombined, upon organic bodies.

7. These organisms are formed of component molecules and integral molecules; they are endowed with electro-chemical properties, like the particles of inorganic matter, but of a different degree of intensity.

8. All organic functions produce only molecular actions and combinations, occasioned by electric currents whose intensity and duration are subordinate to the action of oxygen of the solar fluid, and of caloric upon the living body.

9. Death is only the complete and definitive cessation of these actions, of these electro-chemical combinations, and of the phenomena which result from them.

10. There is a remarkable connection between the universal laws and those of organic bodies;—the first may be subjected to mathematical calculation, by reason of their simplicity; the second, more complicated, can be perfectly known only by pursuing the positive method, or that which is founded on observation, on experiments, and on reasoning;—by combining the notions acquired by means of the methods *à priori* and *à posteriori* as we now regard them;—in short, by following the precept of Bacon: *Qui tractaverunt scientias, aut empirici aut dogmatici fuerunt. Empirici, formicæ more, congerunt tantum et utuntur; rationales, aranearum more, telas ex se conficiunt. Apis vero ratio media est, quæ materiam ex floribus horti et agri elicit, sed*

tamen eam propria facultate, vertit ac digerit.—Jour. des progres des Sci. et Inst. Medicales. 1830. *tome I.*

6. Vegetable Physiology.—*Circulation of Sap.*—At the sitting of the Academy of Sciences, on the 19th of Sept. a report was made by M. de Mirbel on certain observations respecting vegetable anatomy and physiology, communicated by M. Shultz, Professor of the University of Berlin. These observations tend to show a real circulation in the great division of phanerogamous plants resembling that of the blood in animals, and the proofs placed before the persons to whom the communication was referred by the Academy, have led them to regard his discovery as incontestible. In the year 1820, M. Shultz, while examining the plant chelidony conceived the first idea of the circulation in question, and afterwards having directed his researches to many vegetables with one or two cotyledons, and belonging to different genera, he inferred that this circulation was common to all the species. M. de Mirbel remarks that it is astonishing that among so many observers who have devoted themselves to the study of animal and vegetable physiology no one should have remarked this fact, and still more so that since it had been announced no person in France had been able to prove its reality. The preparations for observing it are, however, simple. M. Shultz raised by the aid of a sharp instrument a portion of the epidermis or outer bark of the *Ficus elastica* leaving the cellular tissue and the vessels of the stipule naked. A fragment of this organ is plunged into water and placed before the microscope, when the observer sees the whole vascular apparatus destined for the circulation, composed of long parallel bundles of vessels connected with each other by a loose net work of vessels of the same kind. In these the sap is seen flowing in little capillary torrents. The committee of the Academy not thinking their first observations sufficient, M. Shultz showed them the movement of the sap through the epidermis of an entire leaf, a plant of chelidony, to the stalk of which it was yet attached. A clear day is chosen, the microscope is so placed that its mirror shall reflect the rays of the sun, the leaf is moistened and placed so as to direct the sight upon a vein thin enough to admit the passage of the light. By means of the transparancy of the tissue a scintillation is then observed, owing to the refraction of the luminous rays by the particles which the sap carries along with it, and if the vessels are near to the epidermis the direction of the current is clearly manifest.

7. *Motion of living particles in all kinds of matter.*—A memoir by Robert Brown appeared in London in 1829, announcing that a microscopic examination had proved "that all bodies organic and inorganic,

contain animated self moving particles of the same form and size in every kind of matter, and having similar motions."

This question having been brought before the French Academy, Ad. Brogniart presented a memoir upon it, stating that it is a character common to the reproductive particles of all organized beings to enjoy an individual vitality, manifested by spontaneons motions. R. Brown extends this proposition to all the bodies in nature. Dr. Schultze, of Carlsruhe, has examined the doctrine of Brown, and arrives at a result very opposite. He finds the motion which Brown considers as spontaneous to be occasioned by the evaporation of the liquid, and to the imbibition or solution of the particles. If placed in fluid of difficult evaporation, oil, for example, the motion ceases. They are accelerated in alcohol and ether. These motions are of three kinds, *first*, ascent and descent, produced by evaporation; *second*, oscillation, like the supination and pronation of the hand, owing to a successive imbibition of particles; *third*, rotation, owing to a solution of the substance in the fluid.—*Rev. Encyc. Juillet*, 1830.

8. *Large Still.*—The largest condenser for distilling gin ever manufactured has just been made for Mr. Hodges, by Mr. Joseph Hulls, of High Wickham. Its height is fourteen feet six inches, its diameter eight feet. It is calculated that it will distil ten gallons per minute, six thousand per day, or one million eight hundred and seventy eight thousand per annum.—*Morning Herald.*

The productive capacity of this still is by no means so unrivalled as represented. In many Scotch distilleries, where alembics are employed from fifty two to fifty four inches in diameter, and about eight inches in depth, no less than eighty gallons are produced every three minutes and a half.—*Mechanics' Mag. Jan.* 2, 1830.

9. *On the production of magnetism by friction, by* M. Haldat.—Friction has been long known to be capable of producing magnetism, but it was not supposed to be efficacious, unless upon iron either magnetized or in a neutral state. M. Haldat of Nancy has, however, found that all hard bodies may, by means of friction, assist in the decomposition of the magnetic fluid, if it is promoted by the combined action of magnets, which, by themselves, are incapable of producing it. To prove this, take a piece of soft iron wire, a decimeter long (about four inches) and a millimeter ($\frac{1}{25}$ of an inch) in diameter.

If this wire is placed horizontally between two bar magnets, with their opposite poles facing one another, and at such a distance that it cannot be magnetized, it will receive distinct magnetism by friction

with all hard bodies, such as copper, brass, zinc, glass, hard woods, &c.—*Ann. de Chimie, tome XLII, p.* 41.—*Brewster's Journal, July,* 1830.

10. *Hay converted into a silicious glass by lightning.*—In the summer of 1827, a rick of hay, in the parish of Dun near Montrose, was set on fire by lightning, and partly consumed. When the fire was extinguished by the exertions of the farm-servants who were on the spot, there was observed in the middle of the stack a cylindrical passage, as if cut out by sharp instruments. This passage extended down the middle of the stack to the ground, and at the bottom of it there was found a quantity of vitrified matter, which, there is every reason to think, is the product of the silex contained in the hay which filled up the cylindrical passage. The existence of silex in the common grasses is well known, and the color of the porous and vesicular mass is very like that which is obtained from the combustion of siliceous plants. We have been indebted for a specimen of the substance to Captain Thomson of Montrose, who examined the spot almost immediately after the accident had taken place.—*Brewster's Journal, July,* 1830.

11. *Flying in the air.*—On the 6th of September last, *Gay-Lussac, Flourens* and *Navier,* made reports to the French Academy on the memoir of *De Chabrier,* relative to the means of travelling in the air, and to a new theory of animal motions. The following are extracts. It is easy to compare the quantity of action which a man is capable of producing, with that which is required for flying. The bird which hovers in the air spends, at every movement, the quantity of action necessary to raise its weight to the height of 8 metres, while, in the same time, a man cannot raise his own weight, .086 metres; so that the quantity of action is only $\frac{1}{92}$ part of that which the bird exerts to support himself in the air. If man had the power to spend, in as short a time as he pleased, the quantity of action which he commonly spends in eight hours, we find that he might every day support himself in the air during five minutes; but as he is very far from having that faculty, it is evident that he could only sustain himself for a much shorter time, and that this would be but a small fraction of a minute. This approximation shows how chimerical are the attempts made to render man capable of flying in the air. It being impossible for man, and the greater number of quadrupeds to support themselves in the air, it remains to be decided, what it is possible to accomplish, when, by means of gas, lighter than atmospheric air, the weight of a man is supported, and nothing more is necessary than to move forward and direct the apparatus at pleasure.

The use of wings filled with gas, proposed by M. Chabrier, appears impracticable, because the swiftness necessary to produce continued motion by flapping, could not be given them. It appears that a man supported by an aerostat, (balloon,) would act upon the air in a much more advantageous manner, in turning wheels rapidly around with oblique sails, arranged like those of a wind mill. M. Navier, author of this report, has subjected this motion to calculation. It is evident, that supposing the apparatus placed in a perfectly calm atmosphere, a very small force only would be required; but the requisite force, which is in proportion to the cube of the swiftness, would rapidly increase with the motion impressed. The question then consists in finding what velocity, an apparatus suspended to a balloon, might acquire by the strength of a given number of men. The result of the calculation, in which the aerostat is supposed to be spherical, is that the velocity in question increases proportionally to the power $\frac{1}{3}$ of the radius of the aerostat; and if we attribute to this radius a value of 10 metres, which is double of that which commonly occurs, we find that the value of this velocity is about $2\frac{1}{3}$ metres per second. Consequently, the balloon could not be kept motionless against a wind, whose swiftness is about $2\frac{1}{3}$ met. per second, a very feeble motion, since it is that which is just enough to set a wind mill in motion. As several elements which would have increased the necessary force, have been neglected in the calculation, it appears, that notwithstanding the advantage which might be gained by giving to the aerostat a better form than that of a sphere, it may be concluded, that in the most common condition of the atmosphere, the apparatus will be the sport of the winds. No advantage, either, would be gained, by replacing the strength of man, by that of steam, or of compressed air. Man is still the mechanical agent, which, under an equal weight, is capable of producing the greatest possible continued labor. We therefore think, says M. Navier, that the creation of the art of navigating the air, in such a manner as to be really useful, depends upon the discovery of some new motive power, whose action would be adapted to an apparatus much lighter than any of the known powers.

It does not appear that the views of M. Chabrier, present any scheme, likely to attain the desired object.—*Rev. Encyc. Sep.* 1830.

12. *Formation of Hail*, (Bull. d'Hist. Nat. de Moscow.)—Professor *Pérévoschtchikoff*, of Moscow, has attempted to verify by experiment, the objections of Bellain against the theory of Volta, and especially to explain the influence of evaporation on the temperature of liquids. He employs for this purpose a thermometer whose tube is bent upwards at the base. The ball (which of course ascends) is indented at

the top so as to receive a certain quantity of liquid, and thus to measure its temperature as it evaporates. He concludes from his experiments with water, that a prompt evaporation produces cold even under the immediate influence of the sun's rays; and from experiments with spirits of wine, he draws the conclusion that the temperature of a liquid which is evaporating, can rise only when the evaporation is slow. There is then, he observes, no doubt that the cause of the primitive formation of hail lies in the prompt evaporation of the little globules of which the clouds are formed. Occupied exclusively with electricity, Volta (says Prof. P.) lost sight of the principal cause of the refrigeration of the clouds, and the laminated structure of hail stones. The following is the explanation of the Russian philosopher. "When clouds are formed of several thick strata, gradually ascending, they form an obstacle to the free distribution of radiant heat, which, being reflected to the earth, produces that suffocating heat which commonly precedes a storm. At the same time, the sky, above the clouds, being perfectly serene, presents no obstacle to the radiant heat, which emanates freely from their upper surface. Hence, the principal cause of their congelation, on which depends the formation of the nucleus of the hail stone. The specific weight of those nuclei, not allowing them to remain suspended in the cloud, they fall, and traversing different beds of cloud, they become enveloped with successive coats of congealed fluid, corresponding with the number of strata through which they have passed. These hail stones may acquire, by collision, a rotatory motion, which gives them their spherical form." From these views, the author infers the uselessness, and even danger, of paragrèles.—*Bib. Univ. Août*, 1830.

13. *Expansion of Gases.*—If a musket be loaded with a ball, the flight of the latter may be prevented by the pressure of a finger on the ramrod resting on the ball. This is accounted for on the principle, that at first the ball has a feeble velocity, compared with that which it speedily gains by the expansion of the gases, which continues throughout the tube. Hence a long tube carries a ball so much farther than a short one, and hence also a puff from the mouth, which, as it issues from the lips, has the force of not more than $\frac{1}{4}$ of an atmosphere, can drive a ball sixty paces when blown from a sarbacane. The experiment first mentioned requires great caution, for the gun is apt to burst.—*Ibid.*

14. *Leonardi da Vinci.*—In the tenth volume of the fourth edition of the collection of Italian authors, published at Bologna in 1828, is a

"Treatise on the motion and measurement of Waters," by this celebrated painter. The treatise is inedited, and is said to be very remarkable for its scientific accuracy, bearing the impress of its author, who knew so well how to seize upon and faithfully describe the objects upon which he fixed his attention. The manuscript was composed about the year 1500, and had it been published, it would have hastened the progress of Hydraulics. It is said to have been *Leonardi da Vinci* who first ascribed the faint appearance of the dark part of the moon, soon after the change, to the reflected light of the earth.—*Bib. Univ. Mars*, 1830.

Oolite in Situ, in Edenville, Orange Co. N. Y.—In digging for water in this village, a stratum of rock was encountered, fourteen feet from the surface, dipping about 45° to the north-west, which being blown through, proved to be four feet thick: the upper surface of this stratum is oolite, well characterized, to the depth of twelve inches; after which it gradually passes into compact blue lime-rock. Below this stratum no rock appeared for the depth of fifteen feet.

Edenville stands upon the secondary blue lime-stone formation, one-eighth of a mile from the eastern side of the range of primitive white lime-rock. J. P. Young.

Hints and Conjectures respecting some of the Causes of the Earth's Magnetism; by B. F. Joslin, M. D. Prof. of Math. and Nat. Phil. in Union College, in a letter to the Editor.*

The magnetism of the earth may arise from its motion on its axis, and the situation of the poles is such as it should be if a current of electricity passed around the earth from east to west. For when electricity is made to pass round a needle by means of a spiral wire, the end of the needle nearest the zinc end of the battery, or source of the electricity, becomes the north pole when the spiral turns from left to right, according to Mr. Van Beck, or, according to Mr. Bowen, it acquires south polarity. There is no discrepancy in these two results, as has been erroneously supposed. It should be remembered that the north pole of a needle has south polarity, for opposite poles attract each other.

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* This communication ought to have been inserted earlier, but was delayed by accident.

Moreover a needle inclosed in a spiral seven feet in diameter may be magnetized in this way. Hence it is altogether probable that a current passing round the earth, at a great distance, might produce this effect after some time. Hence the sun or moon, or indeed any of the heavenly bodies in our vicinity might produce this effect by their relative motion round the earth, provided the electricity of any of them exceeds that of the earth in intensity. Again, as the magnetizing effect of the calorimoter, is equal to that of a galvanic battery, we know not but heat may be the chief or only magnetizing agent. In this case, the relative motion of the sun round the earth would produce the effect. Again, is there not a current in the atmosphere from east to west? and as the great mass of the atmosphere is usually positive, this would produce the same effect if electricity is the cause. It might also, if heat is the cause; for in the latitude of the trade winds, the mean temperature of the air probably exceeds that of the earth.

The fact, that the magnetizing effect is increased with the number of turns in the spiral, appears to me to be an evidence that it is the transverse or circular, and not the spiral direction which is essential; and that the only advantage of the spiral direction is to keep the current for a longer time in the vicinity of the needle. This is further evinced by the fact that magnetism may be produced by a current simply transverse. But if the spiral direction should be considered essential, it would be easy to show that the different bodies of the solar system describe spirals, and the different portions of our atmosphere a series of partial spirals on the earth's surface. And it is a curious fact which has probably never been noticed, that the position of the poles is as it should be if the earth's magnetism were caused by a magnetizing fluid moving in the direction of these spirals. For it would move from right to left, when proceeding from south to north, and from left to right, when proceeding from north to south, which is perfectly analogous to the experiment with the needle and wire above related. Lastly, I would suggest the possibility that electricity situated above the earth's atmosphere may produce magnetism in a similar way.

P. S. This communication was sent in 1823, to the Editor of the Boston Journal of Philosophy, with a request that it might either be inserted, or communicated to the American Academy of Arts and Sciences. The receipt of it was publicly acknowledged by the editor, but whether it was read before the society I am unable to say, not having seen their transactions.

APPENDIX.*

On the application of the principle of the galvanic multiplier to electro-magnetic apparatus, and also to the developement of great magnetic power in soft Iron, with a small galvanic element;† by Prof. Joseph Henry, of the Albany Academy.‡

For a long time after the discovery of the principal facts in electro-magnetism, the experiments in this interesting department of science could be repeated only by those who were so fortunate as to possess a large and expensive galvanic apparatus. Mr. Sturgeon, of Woolwich, did much towards making the subject more generally known, by shewing that when powerful magnets are used, many of the most interesting experiments can be performed with a very small galvanic combination. His articles of apparatus, constructed on this principle, are of a much larger size, and more convenient, than any before used. They do not however, form a complete set, as it is evident, that strong magnets cannot be applied to every article required, and particularly to those intended to exhibit the action of terrestrial magnetism on a galvanic wire, or the operation of two galvanic wires on each other.

In a paper, published in the Transactions of the Albany Institute, June, 1828, I described some modifications of apparatus, intended to supply this deficiency of Mr. Sturgeon, by introducing the spiral coil on the principle of the galvanic multiplier of Prof. Schweiger, and this I think is applicable in every case where strong magnets cannot be used. The coil is formed by covering copper wire, from $\frac{1}{40}$ to $\frac{1}{20}$ of an inch in diameter, with silk; and in every case, which will permit, instead of using a single conducting wire, the effect is multiplied by introducing a coil of this wire, closely turned upon itself. This will be readily understood by an example: thus, in the experiment of Ampere, to shew the action of terrestrial magnetism on a galvanic current, instead of using a short single wire suspended on steel points; 60 feet of wire, covered with silk, are coiled so as to form a ring of about 20 inches in diameter, the several strands of which are bound together by wrapping a narrow silk ribbon around them. The copper and zinc of a pair of small galvanic plates are attached to the ends of the coil, and the whole suspended by a silk fibre, with the

* This article arrived too late for insertion in its proper place: its importance induces us to give it in an appendix.

† The term galvanic element is used in this paper to denote a single pair of galvanic plates.

‡ In a former number of this Journal, Prof. Henry, was *erroneously* mentioned as being connected with the Rensselaer School at Troy.

galvanic-element hanging in a tumbler of diluted acid. After a few oscillations, the apparatus never fails to place itself at right angles to the magnetic meridian. This article is nothing more than a modification of De la Rive's ring on a larger scale.

Shortly after the publication mentioned, several other applications of the coil, besides those described in that paper, were made in order to increase the size of electro-magnetic apparatus, and to diminish the necessary galvanic power. The most interesting of these, was its application to a developement of magnetism in soft iron, much more extensively, than to my knowledge had been previously effected by a small galvanic element.

A round piece of iron, about $\frac{1}{4}$ of an inch in diameter, was bent into the usual form of a horse-shoe, and instead of loosely coiling around it a few feet of wire, as is usually described, it was tightly wound with 35 feet of wire, covered with silk, so as to form about 400 turns; a pair of small galvanic plates, which could be dipped into a tumbler of diluted acid, was soldered to the ends of the wire, and the whole mounted on a stand. With these small plates, the horse-shoe became much more powerfully magnetic, than another of the same size, and wound in the usual manner, by the application of a battery composed of 28 plates of copper and zinc, each 8 inches square. Another convenient form of this apparatus was contrived, by winding a straight bar of iron 9 inches long with 35 feet of wire, and supporting it horizontally on a small cup of copper containing a cylinder of zinc, when this cup, which served the double purpose of a stand and the galvanic element, was filled with dilute acid, the bar became a portable electro-magnetic magnet. These articles were exhibited to the Institute in March, 1829.

The idea afterwards occurred to me, that a sufficient quantity of galvanism was furnished by the two small plates, to develope, by means of the coil, a much greater magnetic power in a larger piece of iron. To test this, a cylindrical bar of iron, $\frac{1}{2}$ an inch in diameter, and about 10 inches long, was bent into the form of a horse-shoe, and wound with 30 feet of wire; with a pair of plates containing only $2\frac{1}{2}$ square inches of zinc, it lifted 14 lbs. avoirdupois. At the same time, a very material improvement in the formation of the coil suggested itself to me, on reading a more detailed account of Prof. Schweiger's galvanometer, and which was also tested with complete success upon the same horse-shoe; it consisted in using several strands of wire, each covered with silk, instead of one:—agreeably to this construction, a second wire, of the same length as the first, was wound over it, and the ends soldered to the zinc and copper in such a manner that the galvanic current might circulate in the same direction in both, or, in other words, that the two wires might act as one; the effect by this addition was doubled, as the horse-shoe, with the same plates before used, now supported 28 lbs.

With a pair of plates 4 inches by 6, it lifted 39 lbs., or more than 50 times its own weight.

These experiments conclusively proved that a great developement of magnetism could be effected by a very small galvanic element, and also that the power of the coil was materially increased by multiplying the number of wires, without increasing the length of each.

The multiplication of the wires, increases the power in two ways; first, by conducting a greater quantity of galvanism, and secondly, by giving it a more proper direction, for since the action of a galvanic current is directly at right angles to the axis of a magnetic needle, by using several shorter wires, we can wind one on each inch of the length of the bar to be magnetized, so that the magnetism of each inch will be developed, by a separate wire; in this way the action of each particular coil becomes very nearly at right angles to the axis of the bar, and consequently, the effect is, the greatest possible. This principle is of much greater importance when large bars are used. The advantage of a greater conducting power from using several wires might in a less degree be obtained by substituting for them one large wire of equal sectional area, but in this case the obliquity of the spiral would be much greater and consequently the magnetic action less; besides this, the effect appears to depend in some degree on the number of turns which is much increased by using a number of small wires.*

In order to determine to what extent the coil could be applied in developeing magnetism in soft iron; and also to ascertain, if possible, the most proper length of the wires to be used—

A series of experiments were instituted jointly by Dr. Philip Ten-Eyck and myself. For this purpose 1060 feet (a little more than $\frac{1}{5}$ of a mile) of copper wire of the kind called bell wire, .045 ($\frac{45}{1000}$) of an inch in diameter, were stretched several times across the large room of the Academy.

Experiment 1. A galvanic current from a single pair of plates of copper and zinc 2 inches square, was passed through the whole length of the wire, and the effect on a galvanometer noted;—From the mean of several observations, the deflection of the needle was 15°.

Exp. 2. A current from the same plates was passed through half the above length (or 530 feet) of wire, the deflection in this instance was 21°.

By a reference to a Trigonometrical table, it will be seen that the natural tangents of 15° and 21° are very nearly in the ratio of the square roots of 1 and 2, or of the relative lengths of the wires in these two experiments.

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* Several small wires conduct more common electricity from the machine than one large wire of equal sectional area; the same is probably the case though in a less degree, in galvanism.

The length of the wire forming the galvanometer may be neglected, as it was only 8 feet long. This result agrees remarkably with the law discovered by Mr. Ritchie and published in the last No. of the Journal of the Royal Institution of Great Britain.

Exp. 3. The galvanometer was now removed, and the whole length of the wire attached to the ends of the wire of a small soft iron horse-shoe, $\frac{1}{4}$ of an inch in diameter and wound with about 8 feet of copper wire with a galvanic current from the plates used in Exps. 1 and 2; the magnetism was scarcely observable in the horse-shoe.

Exp. 4. The small plates were removed and a battery composed of a piece of zinc plate 4 inches by 7 surrounded with copper, was substituted, when this was attached immediately to the ends of the 8 feet of wire wound round the horse-shoe, the weight lifted was $4\frac{1}{2}$ lbs.; when the current was passed through the whole length of wire (1060 feet) it lifted about half an ounce.

Exp. 5. The current was passed through half the length of wire (550 feet,) with the same battery, it then lifted 2 oz.

Exp. 6. Two wires of the same length as in the last experiment were used, so as to form two strands from the zinc and copper of the battery; in this case the weight lifted was 4 oz.

Exp. 7. The whole length of the wire was attached to a small trough on Mr. Cruickshank's plan, containing 25 double plates, and presenting exactly the same extent of zinc surface to the action of the acid as the battery used in the last experiment. The weight lifted in this case was 8 oz., when the intervening wire was removed and the trough attached directly to the ends of the wire surrounding the horse-shoe it lifted only 7 oz. From this experiment, it appears that the current from a galvanic trough is capable of producing greater magnetic effect on soft iron after traversing more than $\frac{1}{5}$ of a mile of intervening wire, than when it passes only through the wire surrounding the magnet. It is possible that the different states of the trough, with respect to dryness, may have exerted some influence on this remarkable result; but that the effect of a current from a trough, if not increased, is but slightly diminished in passing through a long wire is certain. A number of other experiments would have been made to verify this had not our use of the room been limited, by its being required for public exercises.

On a little consideration however, the above result does not appear so extraordinary as at the first sight, since a current from a trough possesses more projectile force, to use Prof. Hare's expression, and approximates somewhat in intensity to the electricity from the common machine. May it not also be a fact that the galvanic fluid, in order to produce the greatest magnetic effect, should move with a small velocity, and that in passing through one fifth of a mile, its velocity is so retarded as to produce a greater magnetic action? But be this as

it may, the fact, that the magnetic action of a current from a trough is, *at least*, not sensibly diminished by passing through a long wire, is directly applicable to Mr. Barlow's project of forming an electro-magnetic telegraph, and also of material consequence in the construction of the galvanic coil. From these experiments, it is evident that in forming the coil we may either use one very long wire or several shorter ones as the circumstances may require; in the first case, our galvanic combinations must consist of a number of plates so as to give projectile force; in the second, it must be formed of a single pair.

In order to test on a large scale, the truth of these preliminary results, a bar of soft iron, 2 inches square and 20 inches long, was bent into the form of a horse-shoe, 9½ inches high, the sharp edges of the bar were first a little rounded by the hammer, it weighed 21 lbs.; a piece of iron from the same bar weighing 7 lbs. was filed perfectly flat on one surface for an armature or lifter; the extremities of the legs of the horse-shoe were also truly ground to the surface of the armature: around this horse-shoe 540 feet of copper bell wire were wound in 9 coils of 60 feet each; these coils were not continued around the whole length of the bar, but each strand of wire, according to the principle before mentioned, occupied about two inches and was coiled several times backward and forward over itself; the several ends of the wires were left projecting and all numbered, so that the first and the last end of each strand might be readily distinguished. In this manner, we formed an experimental magnet on a large scale, with which several combinations of wire could be made by merely uniting the different projecting ends. Thus, if the second end of the first wire be soldered to the first end of the second wire, and so on through all the series, the whole will form a continued coil of one long wire. By soldering different ends, the whole may be formed into a double coil of half the length, or into a triple coil of one third the length, &c. The horse-shoe was suspended in a strong rectangular wooden frame 3 feet 9 inches high and 20 inches wide, an iron bar was fixed below the magnet so as to act as a lever of the second order; the different weights supported, were estimated by a sliding weight in the same manner as with a common steelyard. See the sketch of the magnet.

In the experiments immediately following,* a small single battery was used, consisting of two concentric copper cylinders, with zinc between them; the whole amount of zinc surface exposed to the acid from both sides of the zinc was ⅔ of a square foot; the battery required only half a pint of dilute acid for its submersion.

Exp. 8. Each wire of the horse-shoe was soldered to the battery in succession, one at a time; the magnetism developed by each was just sufficient to support the weight of the armature, weighing 7 lbs.

* All the weights in this series of experiments are avoirdupois.

Exp. 9. Two wires, one on each side of the arch of the horse-shoe, were attached; the weight lifted was 145 lbs.

Exp. 10. With two wires, one from each extremity of the legs, the weight lifted was 200 lbs.

Exp. 11. With three wires, one from each extremity of the legs, and the other from the middle of the arch, the weight supported was 300 lbs.

Exp. 12. With four wires, two from each extremity, the weight lifted was 500 lbs. and the armature; when the acid was removed from the zinc, the magnet continued to support, for a few minutes, 130 lbs.

Exp. 13. With six wires, the weight supported was 570 lbs.; in all these experiments, the wires were soldered to the galvanic element; the connexion, in no instance, was formed with mercury.

Exp. 14. When all the wires, (nine in number,) were attached, *the maximum weight lifted was* 650 *lbs.* and this astonishing result, it must be remembered, was produced by a battery containing only $\frac{2}{5}$ of a square foot of zinc surface, and requiring only half a pint of diluted acid for its submersion.

Exp. 15. *A small battery, formed with a plate of zinc* 12 *inches long and* 6 *wide, and surrounded by copper, was substituted for the galvanic element used in the last experiment; the weight lifted in this case was* 750 *lbs.* This is probably the maximum of magnetic power which can be developed in this horse-shoe, as with a large calorimoter, containing 28 plates of copper and zinc, each 8 inches square, the effect was not increased, and indeed we could not succeed in making it lift as much as with the small battery.

The strongest magnet of which we have any account, is that in the possession of Mr. Peale, of Philadelphia; this weighs 53 lbs. and lifted 310 lbs. or about six times its own weight. Our magnet weighs 21 lbs. and consequently lifts more than thirty five times its own weight; it is probably, therefore, the most powerful magnet ever constructed.

This, however, is by no means the maximum, which can be produced by a small galvanic element, as in every experiment we have made the power increases by increasing the quantity of iron; with a bar similar to the one used in these experiments, but of double the diameter, or of 8 times the weight, the power would doubtless be quadruple, and that too without increasing the size of the galvanic element.

Exp. 16. *In order to ascertain the effect of a very small galvanic element on this large quantity of iron, a pair of plates, exactly one inch square, was attached to all the wires; the weight lifted was* 85 *lbs.*

The following experiments were made with wires of different lengths, on the same horse-shoe.

Exp. 17. With 6 wires, each 30 feet long, attached to the galvanic element; the weight lifted was 375 lbs.

Exp. 18. The same wires used in the last experiment, were united so as to form 3 coils of 60 feet each; the weight supported was 290 lbs. This result agrees nearly with that of Exp. 11, though the same individual wires were not used; from this it appears, that 6 short wires are more powerful than 3 of double the length.

Exp. 19. The wires used in Exp. 10, but united so as to form a single coil of 120 feet of wire, lifted 60 lbs., in Exp. 10, the weight lifted was 200 lbs., this is a confirmation of the result in the last experiment.

Exp. 20. The same wires used in the last Exp., were attached to a small compound battery, consisting of 2 plates of zinc and 2 of copper, after the plan of Prof. Hare, and containing exactly the same quantity of zinc surface, as the element in the last Exp., in this case the weight lifted was 110 lbs., or nearly double of that in the last. This result is in strict accordance with that of Exp. 7, the two plates having more projectile force, and thus produce a greater effect with a long wire.

In these experiments a fact was observed, which appears somewhat surprizing, when the large battery was attached and the armature touching both poles of the magnet, it was capable of supporting more than 700 lbs. but when only one pole is in contact it did not support more than 5 or 6 lbs., and in this case we never succeeded in making it lift the armature (weighing 7 lbs.). This fact may perhaps be common to all large magnets, but we have never seen the circumstance noticed of so great a difference between a single pole and both.

A number of experiments were also made with reference to the best form of the iron to receive magnetism, but no very satisfactory results were obtained; of these however, the following are considered as not uninteresting.

Exp. 21. A cylindrical bar of iron weighing 13 oz. $4\frac{1}{2}$ drachms, and bent into a horse-shoe, was covered with 2 coils of wire each 60 feet long; with the small battery used in the last Exp., it lifted 42 lbs.

Exp. 22. A rectangular flat bar $\frac{15}{16}$ of an inch wide, and $\frac{1}{5}$ of an inch thick, also bent into a horse-shoe, weighing 9 oz. 3 dr., and of exactly the same surface as the bar used in the last Exp., lifted, with the same wires and battery, 35 lbs.

Exp. 23. A piece of a gun barrel, little less than an inch in diameter and about 8 inches long, and from $\frac{1}{12}$ to $\frac{1}{15}$ of an inch thick, weighing 8 oz. $3\frac{2}{3}$ dr. with the wires and battery as before, lifted 40 lbs.

From the last Exp., it appears that a given quantity of iron in the form of a hollow cylinder, is capable of receiving more magnetism than that of a solid cylinder of less diameter, but it is evident from Exp. 21, that a solid bar of the same diameter as the gun barrel, and

of greater weight would have lifted more; perhaps the gun barrel was not sufficiently thick for the full developement of magnetism, which, according to Barlow's experiments, resides near the surface.*

A series of experiments† were separately instituted by Dr. Ten Eyck in order to determine the maximum developement of magnetism in a small quantity of soft iron; from these the following interesting results were obtained.

Experiment 1. A horse-shoe of round iron $\frac{56}{100}$ of an inch in diameter, 4 inches long, weighing 2314 grains and wound with 23 ft. copper-wire diameter $\frac{45}{100}$ of an inch, with a pair of one inch plates, lifted 19 lbs. 5oz. 6 dwt. 16 grs.; with a pair of 4 inch plates, lifted 25lbs. 6 oz. 5 dwt.; with the cylindrical element used in Exps. 8, 9 and 10 of former series, it lifted 42 lbs. 6 oz. 8 dwt. 8 grs., or 105 times its own weight.

Exp. 2. A horse-shoe of round iron $\frac{1}{4}$ inch in diameter, $3\frac{1}{2}$ inches in length weighing 310 grains, and wound with 15 ft. copper wire, diameter $\frac{45}{100}$ inch, with a pair of one inch plates, lifted 3 lbs. 11 oz. 7 dwt. 22 grs.; with 4 inch plates it lifted 5 lbs. 5 oz. 12 dwt. 12 grs.; with the cylindrical element 8 lbs. 2 oz. 8 dwt. 18 grs., or 152 times its own weight.

Exp. 3. A horse-shoe formed of a flat bar $2\frac{1}{10}$ inches long $\frac{3}{10}$ broad and $\frac{6}{100}$ thick, weighing 84 grains, and wound with 16 ft. of brass wire, $\frac{2}{100}$ of an inch in diameter, with a pair of one inch plates, lifted 5 lbs. 2 oz. 3 dwt. 8 grs.; with 4 inch plates, lifted 2 lbs. 10 oz. 2 dwt. 12 grs.; with the cylindrical element 2 lbs. 10 oz. 13 dwt. 2 grs., or 198 times its own weight.

Exp. 4. A horse-shoe of round iron slightly flattened, one inch in length, diameter, (before flattening) $\frac{6}{100}$ inch, weight 6 grains and wound with 3 feet brass wire same diameter as that of No. 3. with a pair of one inch plates, lifted 2 oz. 15 d. 1 gr.; with four inch plates, lifted 3 oz. 17 dwt. 10 gr.; with the cylindrical element 5 oz. 5 dwt. 4 grs., or 420 times its own weight.

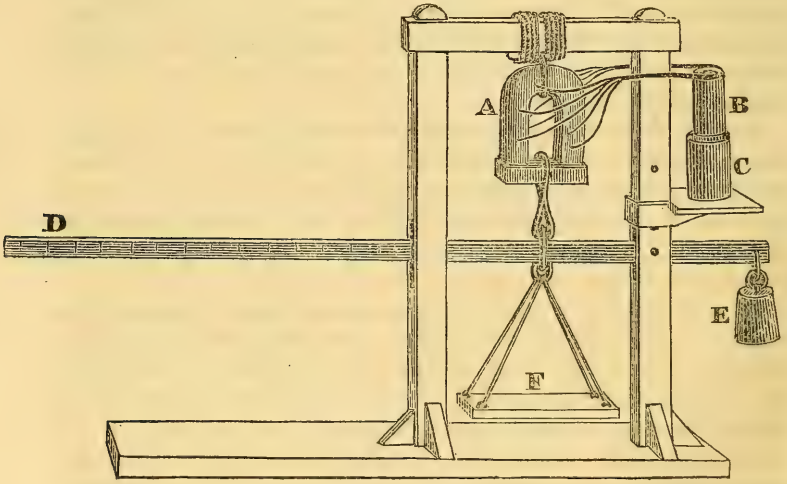
In this last result the ratio of the weight lifted, to the weight of the magnet is much greater than any we have ever seen noticed; the strongest magnet we can find described is one worn by Sir Isaac Newton in a ring, weighing 3 grains, it is said to have taken up 746 grs. or nearly 250 times its own weight. M. Cavallo has seen one of 6 or 7 grs. weight which was capable of lifting 300 grs. or about 50 times its own weight. From these experiments it is evident, that a much greater degree of magnetism can be developed in soft iron by a galvanic current, than in steel by the ordinary method of touching.

Most of the results given in this paper, were witnessed by Dr. L. C. Beck, and to this gentleman we are indebted for several sugges-

* See Barlow's Essay on Magnetic attractions, page 50.
† Troy weight is used in these experiments.

tions, and particularly that of substituting cotton well waxed for silk thread, which in these investigations, became a very considerable emit of expense; he also made a number of experiments with iron bonnet wire, which, being found in commerce already wound, might possibly be substituted in place of copper:—the result was that with very short wire the effect was nearly the same as with copper, but in coils of long wire with a small galvanic element it was not found to answer; Dr. Beck also constructed a horse-shoe of round iron, one inch in diameter, with four coils on the plan before described; with one wire it lifted 30 lbs., with two wires 60 lbs., with three wires 85 lbs., and with four wires 112 lbs.

While engaged in these investigations, the last No. of the Edinburgh Journal of Science was received, containing Prof. Moll's paper on Electro-Magnetism, some of his results are, in a degree, similar to those here described: his object, however, was different, it being only to induce strong magnetism on soft iron with a powerful galvanic battery. The principal object in these experiments was to produce the greatest magnetic effect, with the smallest quantity of galvanism. The only effect Prof. Moll's paper has had over these investigations, has been to hasten their publication: the principle on which they were instituted was known to us nearly two years since, and at that time exhibited to the Albany Institute.



A, the magnet covered with linen, the ends of the wires projecting so as to be soldered to the galvanic element B. C, a cup with dilute acid on a moveable shelf. D, a graduated lever. E, a counterpoise. F, a scale for supporting weights; when a small sliding weight on the lever is not used; a second galvanic element is attached to the appparatus so that the poles of the magnet can be instantly reversed, this is omitted in the figure.

By inverting the large magnet, it sets in motion a very large revolving cylinder of March and Ampère.

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